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ABSTRACT

The science curriculum for the Fort Benton school system was developed with funds under Title III of the Elementary and Secondary Education Act to give students the background of a modern and forward-looking program in science taught in an imaginative, investigative, and inquiry-oriented fashion. The science curriculum guide outlines a planned scope and sequence for grades K-12 with material divided into conceptual topics that are arranged by appropriate learning level. The sequence consists of general science, life science, physical science, earth science, biology, chemistry, physics, and advanced biology. Ten basic goals are presented relating to the student's ability to utilize observational techniques, develop classification schemes, communicate using scientific technology, and understand and apply scientific concepts. Goals and resource materials for each grade level are specified. (JH)

FORT BENTON SCIENCE CURRICULUM OUTLINE

# science

TABLE OF CONTENTS

FOR

FORT BENTON SCIENCE CURRICULUM OUTLINE

# PREFACE

The means by which a small rural school system might provide a continuing curriculum development process are limited fiscally in most areas of Montana. Through the acquisition of a federal grant under ESEA Title III, we in the Fort Benton System have been able to overcome this limitation to some degree. Found in the pages of this curriculum outline are the efforts of Fort Benton teachers and administrators as well as the efforts of personnel from seven other Montana schools.

In today's paper world we often measure success by the volume of the printed word. The efforts put forth by the people involved in this project in no way can be acknowledged simply through an observance of volume. The real success of the program appears in the regeneration of teaching philosophy, methodology and enthusiasm. These in most part will show in the benefits rendered the students in the years to come.

I am not only proud to have been a part of this project, but also thank all the people involved for their cooperation. Any success or benefits of the project are theirs.

Members of this project from the Fort Benton School System will be available for consultant service to any organization or school district with regard to the outline contained herein or any other part of the project.

William J. Hoppes
Superintendent of Schools

## STATEMENT OF PHILOSOPHY

We believe we live in an age of science and it is essential that students of today, who will occupy positions in tomorrow's society in the twenty-first century, have the background of a modern and forward-looking program in science. Therefore, we want to teach modern science in an imaginative, investigative and inquiry-oriented fashion.

We believe in order to develop such a meaningful science curriculum, a planned scope and sequence must be used. Therefore, we have divided the material into conceptual topics which are arranged into appropriate learning levels. These conceptual topics are in the three major areas of science: Life, Earth, and Physical.

We hope the student, through inquiry and experimentation, will become actively involved in the learning process, thereby developing an appreciation of what science has done and can do for everyone in everyday life.

# INTRODUCTION

This Science Curriculum was developed primarily for the Fort Benton School System by a committee representing several Montana School Districts. The project was funded through an ESEA Title III grant to the Fort Benton Public Schools.

The writing of this curriculum outline involved a highly concentrated six-week effort on the part of each individual committeeman. The science project personnel were:

| | | |
|---|---|---|
| James A. Longin | Fort Benton | Project Director |
| Jack Lepley | Fort Benton | Group Leader |
| Diane McSweeney | Fort Benton | Student Consultant |
| Patricia Konen | Fort Benton | |
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| Walter Marten | Fort Benton | |
| William Kindzerski | Fort Benton | |
| Fern Woodcock | Chester | |
| Richard McCrea | Chester | |

# TERMINOLOGY

1. ACQUAINT - to make familiar.
2. APPLY - use appropriately.
3. ASCERTAIN - to find out.
4. ASSUME - to take it for granted.
5. BEHAVIORAL INSTRUCTIONAL OBJECTIVE - refers to those objectives used to measure the terminal behavior of the student which are intended to help develop the behavioral concept and in turn the grade level theme.
6. BEHAVIORAL CONCEPT - refers to those concepts written in behavioral terms which are intended to further develop the grade level theme.
7. CALCULATE - to find out beforehand by any process of reasoning; to estimate.
8. CATEGORIZE - to put into a class according to some system.
9. CHARACTERIZING - describe the special qualities or features of.
10. CLASSIFY - group according to some system.
11. COLLECT - gather together.
12. COMMUNICATION - the exchange of thought between persons by speech or letter.
13. COMPARE - to point out likenesses.
14. COMPILE - to bring together in one list or account.
15. COMPUTE - to find out by rhythmatical or other mathematical means.
16. CONCLUDE - to come to a decision about.
17. CONDUCT - to execute.
18. CONSTRUCT - to put together or build.
19. CONTRAST - to compare so as to show their differences.
20. DEDUCE - infer from a general rule to reach a conclusion by reasoning.
21. DEFINE - to establish or state clearly with authority.
22. DEMONSTRATE - explain by using experiments and examples.
23. DERIVE - to draw as a conclusion.
24. DESCRIBE - to tell or write about.



DETERMINE - to find out exactly to reach a certain result.

26. DEVELOP - work out in greater detail.

27. DIFFERENTIATE - to recognize and state differences.

28. DISCOVER - see or learn of for the first time.

29. DISCUSS - to talk something over with others considering all sides of a question.

30. ENVIRONMENT - surroundings; especially the conditions or influences that affect the growth and development of a person, animal or plant.

31. ESTABLISH - show beyond dispute.

32. EVALUATE - to examine and judge concerning the worth.

33. EXPLAIN - to make plain or clear; interpret.

34. EXPRESS - to put into words.

35. GOALS - refers to those ten basic goals established by this committee as the overall concern of this curriculum.

36. IDENTIFY - to rpove that a thing is the same as that which is already known.

37. INDICATE - to point out or make known.

38. INFER - find out by reasoning.

39. INTERDEPENDENCE - the act of depending on one another; a mutual dependence.

40. INTERPRET - to explain or tell the meaning of.

41. INVESTIGATE - search into, examine closely.

42. LEISURE TIME - the time which is apart from an individual's work time.

43. LIST - catalogue.

44. OBSERVE - examine for some special purpose.

45. OPERATE - perform or function.

46. PERFORM - carry out a process.

47. PREDICT - to make known beforehand as something that is to happen.

48. PROVE - to establish the validity of.

49. REALIZE - to understand clearly.

50. RECITE - to tell in detail; to relate; to answer questions about a lesson.

51. RECOGNIZE - to recall knowledge.

52. RECORD - to set down in writing.

53. RELATE - to give an account of.

54. SELECT - to choose or pick out.

55. SUMMARIZE - give only the main points of or express briefly.

56. UNDERSTAND - to develop a knowledge of.

57. VISUALIZE - to form a mental picture.

## BASIC GOALS

Ten basic goals have been identified in the field of science K-12; these are as follows:

1. Each student should be able to utilize observational techniques in the natural and physical science areas using all his senses.

2. Each student should be able to develop classification schemes according to similarities and differences.

3. Each student should be able to communicate orally and in writing the general terminology required in the scientific areas.

4. Each student should be able to make useful application of scientific concepts in everyday life.

5. Each student should be able to use known facts to explain natural and physical phenomena.

6. Each student should be able to utilize the skills of scientific investigation.

7. Each student should be able to infer both deductively and inductively from evidence at hand.

8. Each student should be able to maniuplate scientific apparatus.

9. Each student should be able to develop an understanding and appreciation of himself and his interdependence to the total environment.

10. Each student should be able to develop an appreciation of the contribution of science to everyday life.

## THEMES AND THEIR RATIONALE

At each grade level a theme is identified and a rationale is indicated for that theme.

| Grade Level | Theme | Rationale |
|---|---|---|
| K-3 | General Science | 1. Because science is interwoven with the primary child's daily activity, the following rationale for teaching science in the primary grades, we feel, has to be of a general and exploratory nature.<br>2. Because a primary child has a natural curiosity, his interest in science can be developed and expanded.<br>3. Because of his eagerness to use all of his senses, the primary child can be made aware of scientific method.<br>4. Because of his need for active involvement, the primary child will develop an appreciation and enjoyment of science.<br>5. We believe that in order to maintain and preserve life on earth, a primary child learns to recognize the importance of his relationship to his environment.<br>6. Because of the complex nature of science, we feel that a sequential development in primary grades is necessary.<br>7. The primary child can be motivated to develop hobbies in science. |
| 4-6 | General Science | 1. Plants and animals are of a major interest to the intermediate age child and the child can be motivated through his natural curiosity.<br>2. Psychologically, an intermediate child should be able to understand the logical order of the earth's formation.<br>3. The child's natural interest in the stars and associated phenomena is ideally suited to developing an understanding of our ever-changing universe.<br>4. The child has an increasing need to know the physical and chemical make-up of the universe; therefore, a sequential development of the topic of matter should create an interest in atoms and molecules which make up matter.<br>5. Our technology is based on energy and the child needs to understand the historical development and the increasing importance of energy in today's world.<br>6. Because of the intermediate child's awareness of the maturation of his body, we feel that basic body structure and function should be taught at this level. |

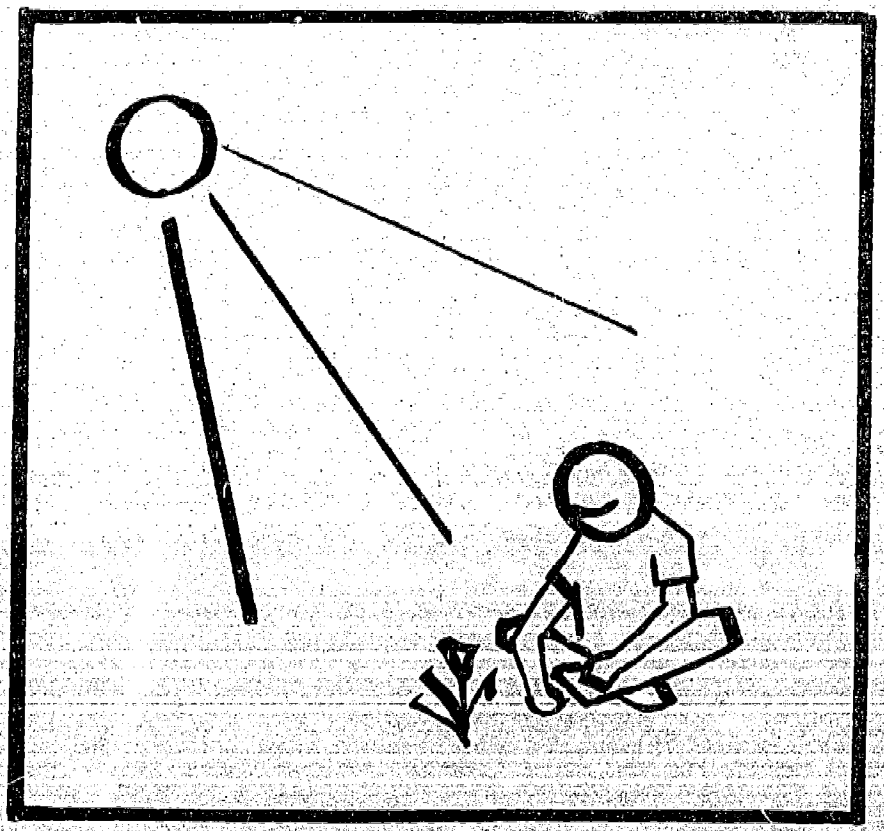
| Grade Level | Theme | Rationale |
|---|---|---|
| | | 7. Because of his ability to record, measure and calculate, we can extend the development of the scientific method. |
| | | 8. Because science is interwoven with other subject matter, it should be correlated with all related curriculum areas. |
| | | 9. Because of his involvement in science, a student can be motivated to adopt appropriate hobbies. |
| | | 10. Since learning is approached in a spiral hierarchy, the child is led step-by-step from the simple to the complex. |
| 7 | Life Science | 1. Due to the transition of the student from elementary to junior high, we feel that the familiarity of the student with living things and his surroundings will help make an easier adjustment for him at this level. |
| | | 2. At this impressionable and inquiring age, we feel that living things best excite the child in the area of science and thus build an enthusiasm that will carry throughout junior high science. |
| | | 3. We feel that the best sequence in science is to start with the area that the student has familiarity with and then move to areas of less familiarity. |
| | | 4. Because of the social implication and body maturation at this level, life science should be taught to develop an understanding of functioning of the body within his environment. |
| 8 | Physical Science | 1. The sequence we have adopted from the familiar to the less familiar fits physical science at this level. |
| | | 2. Because science is required at the 7th and 8th grades, we feel that students should have an overall understanding of the major areas; therefore, physical science is taught at this level. |
| | | 3. Because of the necessity of certain math skills in physical science, we feel a student is better prepared to cope with physical science at this level with his additional background in mathematics. |
| 9 | Earth Science | 1. Because earth science requires an understanding of some basic ideas in both physical and life science, we feel a student needs this background before he enters this course. |

| Grade Level | Theme | Rationale |
|---|---|---|
| | | 2. Because earth science is an extension combining the physical and living worlds in a more in-depth study of phenomena of our earth, we feel that this should be an elective subject and is placed at this level. |
| 10 | Biology | 1. Because one laboratory science at the high school level is required by the State Department, we feel that the exposure to ones self and his environment is of most value to the terminal student in science.<br>2. Because of our belief that we should progress from the familiar to the less familiar, we feel that biology should be taught at the tenth grade level.<br>3. A student should be familiar with his body and how it functions as well as how man controls and effects the environment in order to maintain and preserve life on the earth. |
| 11 | Chemistry | 1. We feel in the normal progression of science that chemistry is best taught at this level because it forms a basis in which to build a foundation and basic knowledge for physics.<br>2. Because of the need of most college-bound students and because most tend to diversify at the twelfth grade level into manu-related areas, we feel chemistry is best taught at this level. |
| 11 or 12 | Physics | 1. Because of the need for the mathematical theory and skills, we feel that physics is best taught at this level after advanced math I course is completed.<br>2. Because physics utilizes material and knowledge from many other science areas plus the use of material of other courses, we feel physics should be taught at the highest level.<br>3. Because of the necessity to be able to perceive and to make judgments in the theory of physics, we feel that it should be taught at the final year in secondary school.<br>4. Because physics scientifically explains much of the application of all science, we feel that the student must first be exposed to the many examples before an understanding can be developed in the theory and workings of these scientific laws. |
| 11 Or 12 | Advanced Biology | 1. Since many of the students in science at this level will be going on to college, it is felt a course of this nature is of great importance. |

## GENERAL NOTES

1. The concepts to be developed in the elementary have been divided into two major groupings - Primary and Intermediate. Levels of presentation of each concept and sub-concept have been indicated.

2. Reference materials for the Primary levels (K-3) are to be found at the end of the third grade concepts. Reference materials for the Intermediate levels (4-6) are to be found at the end of the sixth grade concepts.



# PLANTS & ANIMALS
# SOLAR SYSTEM
# MATTER
# ENERGY

KINDERGARTEN THROUGH GRADE THREE

GENERAL SCIENCE

I. Develop an understanding of plants and animals.

Objective: Each student should be able to understand and appreciate the interdependence and the changes that occur among things with their environment.

| LEVEL | | |
|---|---|---|
| | A. | Classification |
| K | 1. | Each student will be able to identify and group living things:<br>a. Plants vs animals.<br>b. Plants (e.g., trees vs flowers).<br>c. Animals (e.g., wild and domestic). |
| 1 | 2. | Each student will be able to categorize plants and animals according to general characteristics (e.g., color, texture, shape, movements). |
| 2 | 3. | Each student will be able to classify plants and animals according to their environment. |
| 3 | 4. | Each student will be able to classify according to class characteristics (e.g., birds, mammals, reptiles, amphibians). |
| | 5. | Each student will be able to group plants by structural characteristics (e.g., green and non-green, reproductive, with or without tubes (vascular)). |
| | B. | Growth |
| K | 1. | Each student will be able to observe simple stages in animal growth and development (e.g., birth to adult size). |
| 1 | 2. | Each student will be able to observe relationships of growth and development of living things to their environment and food supply (e.g., grow seeds in soil, fish in aquarium). |
| | 3. | See Food I-D-2. |
| 2 | 4. | Each student will be able to state the needs from the environment of a growing plant. |
| | 5. | Each student will be able to explain that the sun is the source of all energy for growth in living things. |
| | 6. | See V-A-4. |
| | C. | Reproduction |
| K | 1. | Each student will be able to match young with the parent. |
| 1 | 2. | Each student will be able to observe that as animals reproduce their own kind, they have various forms of reproduction (e.g., eggs, bear young alive, cyclic changes (metamorphosis)). |
| | 3. | Each student will be able to observe that seeds and spores are a means of reproduction and that they produce the kind of plant from which they come. |
| 3 | 4. | Each student will be able to differentiate the specific ways of reproduction within the various classes of plants and animals. |
| | D. | Food |
| K | 1. | See Growth I-B-1. |
| 1 | 2. | Each student will be able to observe that living things need food for energy and growth. |

| | |
|---|---|
| 2 | 3. Each student will be able to select nutritious foods for good health (e.g., basic four). |
| | 4. Each student will be able to conclude that green plants are directly or indirectly the source of all foods for animals (e.g., cross reference to growth). |
| | 5. Each student will be able to describe how food is the source of energy for growth, repair and movement. |
| 3 | 6. Each student will be able to explain that within the classes of living things, the sources and kinds of food they use will vary with the environment (e.g., meat-eater, vegetarian - cross reference to ecology). |

E. Sensory Experiences

| | |
|---|---|
| K | 1. Each student will be able to discover that his senses help him learn about the world in which he lives. |
| 2 | 2. Each student will be able to identify the structure and function of the eye and ear. |
| 3 | 3. Each student will be able to investigate that the movement of some molecules can be detected by smell (e.g., perfume, mothballs). |

F. Ecology

| | |
|---|---|
| K | 1. Each student will be able to observe the effects that pollution has on the surrounding environment (e.g., litter, sounds, smoke, exhaust). |
| 1 | 2. Each student will be able to observe the interchange of matter and energy between living things and their environment (e.g., growing plants and animals in a good and poor environment). |
| | 3. See Growth I-B-2. |
| 2 | 4. Each student will be able to observe that the ever-changing environment causes continued adaptation in living things (e.g., seasonal coat, color of animals, deciduous trees). |
| | 5. See Growth I-B-4. |
| | 6. See Growth I-B-5. |
| 3 | 7. Each student will be able to explain that living things are dependent upon soil, water and air from their environment. |
| | 8. Each student will be able to identify that structural changes in living things are a product of their changing environment (e.g., fish have fins and gills, pine trees have needles). |

II. Develop an understanding of the solar system.

Objective: Each student should be able to recognize the earth's place in the ever-changing solar system.

A. Day and Night (rotation)

| | |
|---|---|
| K | 1. Each student will be able to observe the characteristics of day and night. |
| 1 | 2. Each student will be able to observe the causes of day and night (e.g., using flashlight and globe, shadows). |
| 2 | 3. Each student will be able to observe and demonstrate rotation of the earth. |
| 3 | 4. Each student will be able to relate time to the rotation of the earth (e.g., position of sun). |

B. Seasons and Weather (revolution)

| | | |
|---|---|---|
| K | 1. | Each student will be able to observe weather and seasonal changes. |
| 1 | 2. | Each student will be able to contrast weather with seasons. |
| 2 | 3. | Each student will be able to relate revolution of earth to seasons. |
| 2 | 4. | Each student will be able to observe and record weather. |
| 3 | 5. | Each student will be able to compare our climate and weather with other areas. |

C. Earth's Neighbors (planets, moon sun)

| | | |
|---|---|---|
| K | 1. | Each student will be able to observe and discuss sun, moon and stars. |
| 1 | 2. | Each student will be able to realize that the moon shines by reflected sunlight. |
| 1 | 3. | Each student will realize that the sun is a star. |
| 2 | 4. | Each student will be able to relate that the moon in the earth's satellite (e.g., revolution). |
| 2 | 5. | Each student will be able to identify the earth as a planet in the sun's family. |
| 3 | 6. | Each student will be able to identify the relative size of the planets. |
| 3 | 7. | Each student will be able to relate that each planet receives energy in proportion to its distance from the sun. |
| 3 | 8. | Each student will be able to discover interesting facts about earth's neighbors. |
| K-3 | 9. | Each student will be able to observe and discuss man in space. |

III. Develop an understanding of geology as a science.

Objective: Each student should be able to comprehend the formation of the earth and history of living things.

A. Soil

| | | |
|---|---|---|
| K | 1. | Each student will be able to acquaint himself with his physical environment through his senses. |
| 1 | 2. | Each student will be able to collect, observe and classify soil and rocks (e.g., color, taste, texture). |
| 2 | 3. | Each student will be able to discover the different materials in soil. |
| 3. | 4. | Each student will be able to relate the origin and properties of soil (e.g., size of particles, air space, mineral content). |

B. Long, Long Ago

| | | |
|---|---|---|
| K | 1. | Each student will be able to observe and discuss fossils. |
| 1-3 | 2. | Each student will be able to observe and discuss plants and animals have changed over the years (e.g., fossils: (1) adaptation; (2) classification of meat-eaters and plant-eaters). |
| 3 | 3. | Each student will be able to demonstrate and explain how fossils were formed. |

C. Changing Face of the Land

| | | |
|---|---|---|
| K | 1. | Each student will be able to observe that water and wind can wear away the soil. |
| 1 | 2. | Each student will be able to observe and relate the effects of erosion (e.g., wearing away of rocks). |

2 3. Each student will be able to observe the conservation of soil.
3 4. Each student will be able to investigate and explain the conservation of soil.

IV. Develop a knowledge of matter and its role in science.

Objective: Each student will be able to recognize the different state of matter and understand that matter can be changed from one form to another and the total amount remains the same.

A. The Three States of Matter

K 1. Each student will be able to observe the three states of matter (i.e. solid, liquid and gas).
1 2. Each student will be able to observe and investigate that matter exists in three forms and can be changed from one state to another (e.g., ice, water, and steam).
2-3 3. Each student will be able to investigate through his senses that all matter is made up of molecules and the state is determined by molecules in motion (e.g., boiling water, perfume in air, solution of sugar and water).
3 4. Each student will be able to investigate and record that solids can be dissolved or mixed with another substance and solids in solution can be changed back to a solid (e.g., sugar and water, sand and water).

B. Properties of Matter

K 1. Each student will be able to observe that matter occupies space (e.g., water in a glass).
1 2. Each student will be able to observe and investigate that matter occupies space, a solid has a shape, the shapes of liquid and gases can be changed (e.g., rock, water and air in separate bags).
2 3. Each student will be able to acquaint himself with the fact that a molecule is the smallest part of a substance which retains the chemical properties of that substance.
3 4. Each student will be able to determine that when matter changes from one form to another the total amount of matter remains the same (e.g., weight of melting ice).
3 5. Each student will be able to investigate and record that matter has weight and occupies space.
3 6. Each student will be able to demonstrate that elements may be combined to form compounds (e.g., burning sugar).

V. Develop a basic understanding of energy.

Objective: Each student should be able to recognize different forms of energy and understand that forms can be changed from one to another.

A. Sun

K 1. Each student will be able to observe that the sun is our source of heat and light.
1 2. Each student will be able to observe that the sun causes changes in the state of matter (e.g., ice melting).
1-2 3. Each student will be able to observe that the sun is the source of our light energy (e.g., day vs night, sun's burning gases).

2-3 4. Each student will be able to conclude that the sun gives energy that is stored in green plants (e.g., growing trees, green leaves in sunlight vs dark).

3 5. Each student will be able to explain that light energy can be changed to heat energy (e.g., gurn paper with magnifying glass).

6. Each student will be able to explain that the earth gets most of its light energy and heat energy from the sun.

B. Movement

1 1. Each student will be able to observe what causes motion (e.g., wind, electric motor, muscles, etc.).

2. Each student will be able to observe that the speed of doing work is determined by the rate at which energy is used (e.g., tractor vs. hourses, walking vs. running).

C. Energy at Work

1 1. See Ecology I-F-2.

2 2. Each student will be able to observe that fuels contain energy that was stored by green plants (e.g., coal).

3. Each student will be able to observe as fuels burn energy is released (e.g., wood burning).

4. See Food I-D-2.

5. See Food I-D-5.

3 6. Each student will be able to categorize energy into two main forms: stored energy and energy of motion (e.g., still air/moving air, still water/moving water, fuel, food, electricity, electromagnet).

7. Each student will be able to demonstrate that stored energy can be changed into energy of motion (e.g., burning a candle, water wheel).

D. Force and Gravity

K 1. Each student will be able to acquaint himself with gravitational force (e.g., drop a ball).

1 2. Each student will be able to observe gravitational forms (e.g., running water).

3. Each student will be able to observe the forces that overcome gravity (e.g., magnets, muscular).

E. Dark and Light

K 1. Each student will be able to discuss night and day.

1 2. Each student will be able to relate that night and day are caused by the rotation of the earth (cross reference - solar system).

2 3. Each student will be able to demonstrate that chemical energy can be converted to light energy (e.g., battery to light bulb).

4. See Senses I-E-2.

5. Each student will be able to observe some simple properties of light (e.g., transmission, reflection, absorption, and color).

F. Silence and Sound

K 1. See Senses I-E-1.

2 2. Each student will be able to investigate that sound is a result of vibration (energy of motion), (e.g., hit drum, ring bell).

3. Each student will be able to detect some of the simple properties of sound (e.g., pitch, speed as to media reflection).

4. See Senses I-E-2.

C. Machines and Magnets

K 1. Each student will be able to discover that magnets attract some things and not others.
2. Each student will be able to observe that there are many machines that help us to do work.

3 3. See Energy at Work 5-C-3.

PRIMARY RESOURCES K-3:

PLANTS AND ANIMALS

Classification
Books:

Big and Little - Hinde, Cecilia, E Hin (K-3)
True Book of Dinosaurs - Clark, Mary, 568 Cla (K-3)
A Tree is a Plant - Bulla, 582 Bul (K-3)
Animals Everywhere - d'Aulaire, Ingrie & Edgar, E Aul c2 (K-3)
Family Tree - Adamson, Jean, 407 Ada (K-3)
What is a Cow - Darby, Gene, 636.2 Car (K-3)
What is a Chicken - Darby, Gene, 636.5 Car (K-3)
What is a Tree - Darby, Gene, 582 Car (K-3)
What is a Bird - Darby, Gene, 598 Car (K-3)
What is a Plant - Darby, Gene, 580 Car (K-3)
The True Book of Elephants - Posell, Elsa, 599.6 Pos (K-3)
We Like Bugs - Conklin, 595.8 Con (K-3)
Flowers - Wilde, Irma, 582 Wil (3)
I Picked a Flower - Lerner, Sharon, 582.13 Lern (3)
Desert Beauty Story of Cactus - Jeanes, Charlotte, 582 Jen (3)
Which is Which - Russel, Solveig Paulson, 591 Rus (3)
Where Animals Live - Shannon, Terry, 591 S (3)
Animals From Everywhere - Webb, 591 Web (2,3)
All Kinds of Logs - Russell, Solveig, 591.4 Rus (1)
Butterfly Time - Goudy, 595.7 Gou (K-3)
Forest Folk - Buff, 599 Buf (K-3)
Bird Nests - Shakelford, Nina, 598 Sha (1)
If I Were A Bird - Conklin, 598 Con (1)
Hawks - Ripper, Charles, 598.2 (3)
Frogs and Toads - Zim, Herbert, 597.8 Zim (3)
Goldfish - Spencer, Herbert, 597.52 Zim (3)
Tim Tadpole and The Great Bullfrog - Flack, Marjorie, 597.8 Fla (3)
Everyday Bird - Allen, Gertrude, 598 All (3)
Plenty of Fish - Selsam, Millicent, 597 Sel (3)
Red Tag Comes Back - Phleger, Fred, 597 Phl (3)
Ants Are Fun - Myrick, Mildred, 595.79 M (3)
Moths - Hogner, Dorothy, 595.78 Hog (K-3)
When Water Animals Are Babies - Schwartz, Elizabeth, 597 Sch (3)
Birds in Summer - Rand, 598 Ran (K-3)
Birds in Their Homes - Webb, 597 Web (K-3)
First Book of Bees - Tibbets, Albert B., 638 Tib (3)
Monkeys - Zim, Herbert, 599.82 Zim (3)
Camels and Llamas - Earle, Olive L., 599.7 E (3)
Ostriches - Zim, Herbert, 598.5 Zim (3)
Let's Find Out What's Big and What's Small - Shapp, Charles, E Sha (K)
Whose Little Bird Am I - Weissgard, Leonard, E Wei (K)

In Ponds and Streams - Buck, Margaret, 574.92 Buc (3)
Where Does the Butterfly Go - Garelick, E Gar (K-3)
The Song of the Day Birds and The Night Birds - Ipcar, Cahlov, E Ipc (K-3)
I Found a Leaf - Lerner, Sharon, 581 Ler (3)
Sandpipers - Hurd, Edith, 598.2 (2-3)
How Big Am I - Heide, Florence, E 568 (K)
Birds At Night - Gans, Roma, 598.2 G (3)
Ruby Throat - McClung, 598 McC (K-3)
Dogs - Grabianski, Janeen, 636.7 Gra (3)
Birds in the Sky - Hawinson, Leean, 598 Haw (3)
Fireflies in the Night - Haws, Judy, 595.7 Haw (K-3)
Watch Honeybees With Me - Haws, Judy, 595.7 Haw (3)
Praying Mantis - Huntington, 595.7 Hun (3)
Elf Owl - Buff, Mary, 591.9 B (3)
Crickets - Earle, Olive L., 595.7 (3)
When Insects Are Babies - Conklin, Gladys, 595.7c (3)
Collecting Cocoons - Hussey, Lois, 595.7 Hus (3)
Water Beetles - Hognes, Dorothy, 595.7 Hog (3)
Butterflies - Hogner, Dorothy, 595.7 Hog (3)
What is a Fish - Darby, 597 Dar (3)
Alligators & Crocodiles - Zim, Herbert, 598.14 (3)
Buzztail - McClung, 598.1 McC (3)
Strange Lizards - Earle, Olive L., 598.1 Ear (3)
What is Turtle - Darby, Gene, 598.1 Dar (1)
Turtles - Bronson, 498.1 Bro (1)
Birds Do the Strangest Things - Hornblow, Leonora, 598 Hor (2)
Junior Science Book of Canadian Geese - Crosby, Alexander, 598 Cro (2)
Earthworms - Hogner, Dorothy, 595 Hog (3)
Spotted Salamander - McClung - 597 McC (3)
The First Book of Bugs - Williamson, Margaret, 595.7 Wil (3)
Grasshoppers & Crickets - Hogner, Dorothy, 595.7 Hog (3)
Spiders are Spinners - Posen, Ellsworth, 595 Pos (K-3)
The True Book of Spiders - Rodendorf, 595 Rod (K-3)
The Lobster King - Olsen, Einar, 595 O (3)
The True Book of Elephants - Posell, Elsa, 599.6 Pos (K-3)
Elephants - Zim, Herbert, 599 6 Zim (K-3)
Bats - Ripper, Charles L., 599 4 Rip (K-3)
Rabbits in the Meadow - Hess, Lila, 599.3 Hes (K-3)
Kangaroos and Other Animals With Pockets - Darling, Alice, 599.2 Dar (K-3)
The Great Whale - Zim, Herbert, 599 Zim (K-3)
First Book of Mammals - Williamson, 599 Wil (3)
Owls - Zim, Herbert, 398.97 Zim (K-3)
True Book of Animals of the Sea and Shore - Podendorf, Illa, 591.92 Pod (3)
Lucky Lady Bugs - Conklin, Gladys, 595.7 C (3)
All About Dogs - Burger, Carl, 599.7 Bur (3 + I)
Coyotes - Bronson, Wilfred, 599.7 Bro (3)
Here Come the Bears - Goudy, Alice, 599 Gou (3)
Here Come the Deer - Goudy, Alice, 599 Gou (3)
Here Come the Squirrels - Goudy, Alice, 599.3 Gou (3)
The Coyote - Hisen, Iona Seibet, 599 H (3)
The Amazing Animals of Australia - Wise, William, 591.994 Wim (3)
Golden Hamsters - Zim, Herbert S., 636.932 Zim (3)
Rabbits - Zim, Herbert S., 636.9 Zim (3)
The True Book of Tropical Fish - Broekel, Roy, 639 Bro (3)
Everyday Wildflowers - Allen, Gertrude, 582 All (K-3)
The Tallest Tree - Overlie, George, L Over (K-3)
Our Tiniest Animals - Malten, Morton S., 591 M (K-3)
Wild Animals - Rojankovsky, E Roj (K-3)

Billy Bump & Dad - Stewart, E Ste (K-3)
What is a Dinosaur - Posin, Daniel, 568 Pos (K-3)
True Book of Insects - Podendorf, Illa, 597.7 Pod (K-3)
Hidden Animals - Milliant, E. Selsam, 590 Sel (K-3)
Winter Tree Birds - Ozone, Lucy, E Ozo (K-3)
The Tree Book of Weeds & Wildflowers - Podendorf, Illa, 582 Pod (K-3)
The Insect World - Pallister, John, 595.7 P (3)
The True Book of Whales & Other Sea Mammals - Posell, Elsa Z., 599.5 (3)
The Story of Spiders - Shuttlesworth, Dorothy E., 595 Shu (3-6)
The True Book of Trees - Podendorf, Illa, E 582 P (K-3)
Insects - Farb, Peter, 595.7 Far (3-6)
The True Book of Spiders - Podendorf, Illa, 595.4 Pod (K-3)
The How and Wonder Why Book - Reed, Ronald N., 595.7 Reed (3-6)
The True Book of Animal Babies - Podendorf, Illa, 591.5 Pid (K-3)
The Story of Ants - Shuttlesworth, Dorothy, 595.7 Shu (K-3)
The True Book of Trees - Podendorf, Illa, 582 Pod (K-3)
Insects in Their World - Swain, 595.7 Swa (3-6)
Seeds and More Seeds - Selsam, 581 Sel (K-3)
Flowers in Woods and Fields - Wilde, Iram, 582.13 Wil (3)
Small Pets From Woods and Fields - Buck, Margaret, 574 Buc (3-6)

Growth

The Ugly Duckling - Ertel, E Ert (K-3)
Bambi - Disney, E Dis (K-3)
Eggs of Things - Kumin, E K (K-3)
Why Did He Die - Harris, Audrey, 236 Har (K-3)
Seeds and More Seeds - Selsam, Millicent, 581 Sel (K-3)
Seeds By Wind and Water - Jordon, 581 Jor (K-3)
Play With Plants - Selsam, 580 Sel (K-3)
The Wonderland of Plants - Shannon, Terry, 580 S (K-3)
What is a Butterfly - Darby, Gene, 595.7 Dar (K-3)
Chicken Ten Thousand - Jackson, Jacqueline, E J (K-3)
The Carrot Seed - Krauss, Ruth, E Kra (K-3)

Reproduction

When Insects Are Babies - Conklin, 595.7 C (K-3)
Lions in the Grass - Busch, Phyllis S., 582.13 B (K-3)
Milkweed - Selsam, Millicent, 582 Sel (K-3)
Seeds by Wind and Water - Jordon, Helene, 582 Jor (K-3)
Sphinx - McClung, Robert M., 595.7 (3)
Seeds Are Wonderful - Foster, Wilene, 581 Fos (K-3)
What is a Frog - Darby, Gene, 597 Dar (3)
Seeds and More Seeds - Selsam, Millicent, 581 Sel (K-3)
Play With Plants - Selsam, 580 Sel (K-3)
The Wonderland of Plants - Shannon, Terry, 580 S (K-3)
Travelers All - Webber, 580 Web (K-3)
Johnny and The Monarch - Friskey, E Fri (K-3)
What is a Butterfly - Darby, Gene, 595.7 Dar (K-3)
Chicken Ten Thousand - Jackson, Jacqueline, E J (K-3)
The Carrot Seed - Kraus, Ruth, E Kra (K-3)
The True Book of Plant Experiments - Podendorf, 581 Pod (K-3)

Food

I Like Vegetables - Lerner, Sharon, 635 Lern (1,2)
I Like Fruit - Goldman, Ethel, 634 Gold (1,2)

The Apple Book - Martin, Dick, E Mar (K-3)
First Book of Food - Schiele, 641 Sch (K-3)

Sensory Experience

My Five Senses - Aliki, 612 Ali (K-3)
Do You Hear What I Hear? - Borton, Helen, 534 Bor (K-3)
What Could You See - Bendick, Jeanne, 500 Ben (K-3)
Listen! Listen! - Rand, Ann, E Ran (2)
Read About the Hand - Elgin, Kathleen, 612 E (K-3)
Follow Your Nose - Showers, Paul, 612 Sho (2)
Find Out By Touching - Showers, Paul, E Sho (K-3)

Ecology

Once There Was a Tree - Busch, Phyllis, 582.16 Bus (K-3)
The Clean Brook - Barlett, Margaret F., 574.929 Bar (K-3)
Swamp Spring - Carrick, Carol, 574 C (K-3)
Wildfire - Valens, Evans, E V (K)
The Big Snow - Hader, E Had (K-3)
I Play at the Beach - Koch, Dorothy, E Koc (1)
Ladybug, Ladybug, Fly Away Home - Hawkes, Judy, 595.7 (1,2)
Ekorn the Squirrel - Orbach, Ruth, 599 Orb (2)
Thanks to Trees - Webber, 582 Web (3)
Splash and Trickle - Green, Ivah, 333.9 G (3)
The Little Red Flower - Tripp, Paul, E Tri (2)
Let's Find Out Earth - Knight, David, 525 K (K-3)
Like Nothing at All - Fisher, E Fis (2)
The Brook - Carrick, Carol, E (1)
Everyday Wildflowers - Allen, Gertrude, 582.13 All (K-3)

General

Squirrels in the Garden - Earle, Olive, 599.32 Ear (K-6)
The Land and The Wildlife of Africa - Life Periodical, 574.98 (3-6)
The Land and Wildlife of South America - Life Periodical, 574.98 (3-6)
Camouflage in Nature - Ross, Edward S., 591.5 R (3-6)
The True Book of Birds We Know - Frisken, Margaret, 598.2 (K-3)
Birds Eat and Eat and Eat - Gana, Roma, 598.2 Gan (K-3)
It's Nesting Time - Gans, Roma, 598.2 Gans (K-3)
The Golden Book of Animals - Scurry, Richard, E Sca (K-3)
Caterpillars - Sterling, Dorothy, 595.7 Ste (3-6)
The Tall Grass Zoo - Lubell, Winifred, 595.7 Lub (K-6)
A Bird Alphabet - Palozzo, Tony, E. Pal (K-6)
The Geese Are Back - Mannheim, Grete, 598 Man (K-6)
The Moon of the Grey Wolves - George, Jean C., 599.7 Geo (3)
Rabbits in the Meadow - Hess, Lila, 599.3 Hes (K-3)
Zoo Babies - Bridges, William, 591 Bri (K-3)
Here Come the Dolphins - Goudy, Alice C., 599.5 Goud (K-3)
Chip, the Chipmunk - Marsh, 599 Mar (K-3)
Here Come the Bears - Goudy, 599 Gou (K-3)
Koalas Live Here - Eberle, Irmengarde, 599 E (K-3)
A Chipmunk Lives Here - Eberle, Irmengarde, 599 Ebe (K-3)
Bear Country - Disney, 599 Dis (K-3)
Beaver Valley - Disney, 599 Dis (K-3)
White Tale - King of the Forest - Smock, Nell Stolp, 599 Smw (K-3)
Here Come the Cottontails - Goudy, Alice, 599.3 Gou (K-3)
Here Come the Beavers - Goudy, Alice, 599.3 Gou (K-3)

Cottontail Rabbit - Schwartz, 599 Sch (K-3)
Dash and Dart - Buff, 599 Buf (K-3)
Little Stripe - Arumdel, Jocelyn, 599 Aru (K-3)
The First Book of Animals Signs - Colby, Conwell, 599 Col (3-6)
Squirrels in the Garden - Earle, 599 Ear (K-3)
Otus - McClung, Robert, 598.9 McC (K-3)
Let's Go to the Brook - Huntington, 574.92 Hun (3)
Let's Go to the Seashore - Huntington, 574.92 Hun (3,
Let's Go to the Desert - Huntington, 574.92 Hun (3)
Swamp Spring - Carrick, Carol, 574 C (K-3)
Discovering Insects - Blough, Glenn O., 595.7 B (3-6)
Bear Cub - Clark, Ann, 599.7 Cla (3-6)
The Bear Family - Wood, Dorothy, 599 W (K-3)
Funny Squirrel - Stewart - E Ste (K-3)
Flat Tail - Fall, 599 Gal (K-6)
See Our Poney Farm - Stewart - E Ste (K-3)
Sally's Caterpillar - Rockwell, E Roc (K-3)
Happy Day - Krauss, E Kra (K-3)
Come to the Pet Shop - Tensen, E Ten (K-3)
The Good Bird - Wezel, Peter, E Wez (K)
Who Lives in the Meadow - Blough, Glenn, 591 Blo (K-3)
Who Lives in This House - Blough, Glenn, 591 Blo (K-3)
Everyday Animals - Allen, Gertrude, 591 All (K-3)
The Amazing Animals of Australia - Wise, William, 590 Wis (K-3)
Play With Seeds - Selsam, Millicent, 582 Sel (K-3)
Junior Science Book of Bacteria - Lietz, Gerald, 589.9 Lietz (K-3)
Snow Tracks - George, Jean, 591 Geo (K-3)
Hurry, Scurry, and Flurry - Buff, Mary and Conrad, 599 Buf (K-3)
A Crowd of Cows - Graham, John, E (1)
The Old STump - Hawkinson, John, E Haw (K-3)
The Strange World of Dinosaurs - Ostrom, 568 Ost (3)
Hammond's Nature Book - Jordan, 574 Jor (3-6)
Life in the Forest - Snedieja, 574 Sne (3-6)
The Golden Treasury of Natural History - Parker, 574 Par (3-6)
Golden Book of Nature - Saunders, 574 Sau (3-6)
Fall Is Here - Sterling, Dorothy, 574 Ste (3-6)
Natural History - Parker, Bertha, 574 Par (3-6)
Birds At Home - Henry, 598 Hen (3-6)
Birds in their Homes - Webb, Addison, 598.2 Web (3-6)
Adventures of a Squirrel - Ertel, 599 Ert (2,3)
The Community of Living Things in Fresh and Salt Water - Cadbury, B., 574.92 (3-6)
The Land and Wildlife of Australia - Life Periodical, 574.94 Lif (3-6)
Dinosaurs - Holsirt, Eunice, 568 H (3)
The Crab From Yesterday - Waters, John F., 595 Wat (K-3)
Here Come the Elephants - Goudy, Alice, 599.61 Gou (K-3)
Baby Farm Animals - Williams, Garthe, E W (K)
Come to the Farm - Tensen, E Ten (K-3)
The Lazy Beaver - Bowan, E Bow (3)
Symbiosis - Aruego, Jose, E Aru (3)
Animals on the Farm - Plfog, Jan, E Plf (K-3)
Robins and Rabbits - Hawkinson, John, 591 Hawk (K)
Where is Duckling Three - Green, Ival E Gre (K)
Ducks Don't Get Wet - Goldin, Augusta, 598.4 Gol (K-3)
The Guinea Pigs That Went to School - Meshova, Leonard, 599.3 M (K-3)
Whatever Happens to Bear Cubs - Hall, Bill, 599.7 H (K)
Wonders of Nature - Watson, Jane W., E Wat (K-3)
Thistle - Zistel, Eva, E Z (K-3)

The Fish Book - Marten, Dick, E Mar (K-3)
Ekorn the Squirrel - Orbach, Rugh, 599 Orb (K-3)
Tony's Birds - Selsam, 598 Sel (K-3)
The Orderly Cricket - Oetting, Roe, 811 Oet (K-3)
Terry and the Caterpillars - Selsam, 595.6 Sel (K-3)
Up Above and Down Below - Webber, 580 Web (K-3)
Fleet Neil - Gal, 599 Gall (3)

## SOLAR SYSTEM

### Day and Night

Sun Up - Tresselt, E Tre (2)
Wake Up, Farm! - Tresselt, Alvin, E Tre (1)
The Day We Saw The Sun Come Up - Goudey, E Gou (2)

### Seasons and Weather

Will Spring Be Early or Will Spring Be Late? - Johnson, Crockett, E Joh (1)
Country Snowplow - Shortall, Leonard, E S (2)
Who Will Wake Up Spring? - Lerner, Sharon, E Ler (1)
The Snowy Day - Keats, E Kea (1)
Spring Things - Kumin, Maxine, E Kum (1)
A Winter Friend - Kumin, Maxine, E K (1)
Children on a Farm - Graham, 630.1 Gra (2,3)
The Seasons - Jervis, Derek, 525 er (K-3)
Spring Is Here - Lenski, E Len (K-1)
Spring is Like the Morning - Craig, M. Jean, 525 Cra (K-3)
Snow Is Falling - Branley, Franklyn, 551.5 Bra (K-3)
How We Celebrate Our Fall Holidays - Banks, Marjorie Ann, 394.26 Ban (K-3)
How We Celebrate Our Spring Holidays - Banks, Majrorie Ann, 394.2 Ben (K-3)
Let's Find Out About Fall - Shapp, Martha, E S (K-3)
White Snow, Bright Snow - Tresset, E Tre (2)
Autumn Harvest - Tressett, E Tre (2)
Hi, Mister Robin - Tressett, E Tre (1)
Hide & Seek Fog - Tressett, E Tre (2)
Four Seasons With Suzy - Writer's Committee, E Wri (1)
Really Spring - Zion, Gene, E Z (2)
Johnny Maple Tree - Tressett, E Tre (1)
A Tree is Nice - Udry, E Udr (1)
House of Four Seasons - Duvaison, E Duv (K-3)
Summer Story - Kumin, Maxine, E (1)
A Winter Friend - Kumin, Maxine, 811 Kum (1)
Spring Things - Kumin, Maxine, 811 Kum (1)
Follow the Fall - Kumin, Maxine, E Kum (1)
When Spring Comes - Fox, Charles, E F (2)
What Does the Cloud Do - Kinney, Jean, 551.5 Kin (3)
Who Will Wake Up Spring - Lerner, Sharon, E Ler (1)
Come Summer, Come Winter - Shannon, Terry, 525 S (2)
When Winter Comes - Fox, Charles, E F (1)
Snow Time - Schlein, Mariam, E Sch (1)
Let's Find Out About Winter - Shapp, Martha, E Sha (1)
Let's Find Out About Summer - Shapp, Martha, 525 Sha (2)
All Ready for Winter - Adelson, 574 Ade (2)
Katy and the Big Snow - Burton, Virginia Lee, E (K-3)

Earth's Neighbors

A Book to Begin On Outer Space - Holsaert, Eunice, 629.4 H (K-3)
The Sun, The Moon and The Stars - Freeman, Mae & Ira, 523 Fre (K-3)
You Among the Stars - Schneider, Herman & Nina, 523 Sch (K-3)
What is a Solar System - Munch, Theodore W., 523.2 Mun (K-3)
The Moon Seems to Change - Branley, 523.3 Bra (K-3)
A Book of Planets for You - Branley, 523.4 (K-3)
Let's Find Out About Mars - Knight, David, 523.4 Kni (K-3)
What is the Earth? - Darby, 551 Dar (K-3)
The Big Dipper - Branley, Franklny M., 523.8 B (K-3)
Rockets and Sattellites - Branley, Franklyn M., 629.13 (K-3)
What the Moon is Like - Branley, Franklyn M., 523.3 Cl (K-3)
Time of Wonder - McCloskey, E McC (K-3)
Here Comes Night - Schlein, Miriam, E Sch (K-3)
The Sky Was Blue - Zolotov, E Zol (1)
The Sky Dog - Turkle, Brinton, E T (2)
How Far is Far - Tresselt, Alvin, E Tre (1)
Many Moons - Thurber, F Thu (3)
Look at the Moon - Garelick, May, E G (2)
You Will Go to the Moon - Freeman, 629.4 Fre (1)
What Does the Sun Do - Kinney, Jean, 523.7 Kin (3)
True Book of Moon, Sun, Stars - Lewellen, John, 523.2 Lew (1,2)
Rocket to the Moon - Bergaust, 629.1 Ber (K-3)

GEOLOGY

What is a Rock - Syrocki, B. John, 522 Syr (3)
The True Book of Rocks and Minerals - Podendorf, Illa, 522 Pod (3)
True Book of Pebbles - Podendorf, Illa, 594 Pod (2)
What is Soil - Syrocki, B., 631.4 Syr (2,3)
Rain Drop Splash - Tressett, Alvin, E (K-3)
They Lived in the Ice Age - May, Julian, 551.7 May (K-3)
Icebergs - Roma, Gans, 551.3 (K-3)
The True Book of Jungles - Podendorf, Illa, 551.4 Pod (K-3)

MATTER

Burt Dow, Deep Waterman - McCloskey, Robert, E McC (3)
The Earth is Your Spaceship - Schwartz, Julius, E Sch (2)
Air All Around - Pines, Tillie S., 533 Pin (2)
Working With Water - Catheral, E. A., 532 C (K-3)
When Air Moves - Freeman, Mae - 538 F (K-3)
Let's Experiment: Chemistry for Boys and Girls - Straus, 540.7 (K-3)
What's Big and What's Small - Shapp, Charles & Martha, 530 Sha (K-3)
Willy, A Story of Water - Spar, Jerome, 551.4 S (2,3)
Water All Around - Pine, 532 C (K-3)

ENERGY

Sun

The Sunshine - Federico, Helen, E Fed (2)

Energy at Work

What is Heat - Munch, Theodore W., 536 Mun (K-3)

Force and Gravity

Mickey's Magnet - Branley, Franklyn, 538 Bra (K-3)
Adventures With a Ball - Milgram, Harry, 507.2 Mil (1,2)
What is Gravity? - King, Fred, 530.1 Kin (K-3)
One Way Is Down - Fischer, Vera, 531 Fis (K-3)
Gravity All Around - Pine, Tillie S., 531 (K-3)

Dark and Light

What is Light - Munch, Theodore, 534 Mun (K-3)
What Makes a Light Up On - Corbett, Scott, 537 cor (K-3)
Working With Light - Catherell, E. A., 535 C (K-3)
Junior Science Book of Light - Feravolo, Rocco V., 535 Fer (K-3)
Light and Color - Hearley, Frederick, 535 Hea (K-3)

Silence and Sound

What Happens When You Make a Telephone Call - Shay, Arthur, 621.386 S (K-3)
Sounds the Letters Make - Schoolfield, Lucille, 428.3 (K-3)
Wonderful Wheels - Ziner, Feenie, 531 Zin (K-3)
Junior Science Book of Sound - Anderson, Dorothy, 534 And (K-3)
Magic of Sound - Kettlekamp, 534 Ket (K-3)
Working With Sound - Catherall, 534 C (K-3)
Corkey's Garden - Hinde, Cecilia, E Hin (K-3)
The Toll Music - Lobel, Anita, E L (K-3)
Song of the Swallows - Politi - E Pol (K-3)
Lemonade Serenade - Madden, Don, E Mad (K-3)
Adventures With a String - Milgram, Jarry, 507.2 Mil (1,2)
The True Book of Sounds - Podendorf, Illa, 534 Pod (1)
Loud - Parsons, Virginia, E Par (1)
Quiet - Parsons, Virginia, E Par (1)
What's Sound - Reuben, Gabriel, 534 Reu (3)

Machines and Magnets

Wonderful Wheels - Ziner, Feenie, 531 Zin (K-3)
I Want to Be a Mechanic - Greene, Carla, 621 Gree (1)
What is a Magnet? - Reuben, 537 Reu (2,3)
What is a Simple Machine - Danby, 531 Dar (K-3)
Working With Magnets - Catherall, E. A., 538 C (K-3)
Junior Science Book of Magnets - Feravolo, Rocco V., 538 (K-3)
Wings and Wheels - Chapin, Cynthia, 380.3 C (K-3)
Machines at Work - Etting, Mary, 621 Eit (3)
Simple Machines and How They Work - Sharp, Elizabeth, 531 Sha (K-3)
What is a Machine - Syrocki, John, 531 Syr (K-3)

Electricity

Junior Science Book of Electricity - Fervola, Rocco, 537 Fer (K-3)
What is Electricity - Syrocki, John, 537 Syr (K-3)

General

Friction - Howard, Liss, 531 (K-3)
Friction All Around - Pine, Tillie S., 531 Pin (K-3)
Let's Experiment, Chemistry for Boys & Girls - Straus, Jacqueline, 540.7 (K-3)
Scientist Sam - Pape, Donna Lugg, E Pap (2)

Prove It - Wyler, Rose, 507.2 W (K-3)
The True Book of Energy - Podendorf, Illa, 531 Pod (K-3)

## GENERAL SCIENCE

Science is Exploring - Beauchamp, Wilbor L., 500 Beau (K-3)
All Around You - Bendeck, 500 Ben (K-3)
The Little Island - MacDonald, Golden, E Mac (K-3)
Science for You - Frasier, George Willard, 500 E (1)
ABC Science Series - Jacobson, Willard, 500 E (2)
The True Book of Library, Vol. 1-10 - Podendorf, Illa, 500 Pid (1-4)
Science is Learning - Marshall, Stanley, E 500 Mar (2)
The World Is So Big - Huck, Charlotte S., 808.8 Huc (K-3)
ABC Science Series - Jacobson, Willard, E 500 Jac (3)
The Giant Nursery Book of How Things Change - Zaffo, George J., 500 Z (K)
Science All the Year - Frasier, George Willard, E 500 Fra (K-3)
Greg's Microscope - Selsam, Millicent, 578 Sel (K-3)
The Farm - Russell, Solveig, 631 R (K-3)
Desert - Goetz, Delia, 551.45 (3)
Let's Find Out - Schneider, 530.52 Sch (K-3)
Science for Work and Play - D. C. Heath (1)
Science Through Discovery - Singer Co., (1)
The Scientist Observes - Harper & Row (1)
Looking at Science - Lyons & Carnahan (1)
Science is Fun - Scott-Foresman (1)
Science for Here and Now - D. C. Heath (2)
Science Through Discovery - Singer Co. (2)
The Scientist Finds Out - Harper Row (2)
Exploring Science - Ally & Bacon (2)
Science is Learning - Scott-Foresman (2)
The Exciting World of Science - Bobbs Merrill (2)
Science, A Modern Approach - Winston (3)
Knowing About Science - Lyons & Carnham (3)
The Changing World of Science - Merrill (3)
The Basic Science Program - Scott-Foresman (3)
Science Far and Near - Heath (3)
Our Wonderful Wayside - Mawkinson, John, 574 H (3)
Robins on the Window Sill - Eberle, I., 598.2 Ebe (3)
Your Science Fair Project - Moor, William, 507.2 (K-3)
The First Book of Science - Syler, 507.2 Wyl (K-3)
The Desert Water Hole - Church, Jeffrey, 591 Chu (3)
See Through the Jungle - Selsam, Millicent, 574 Sel (3)
I Saw the Sea Come In - Tressett, E Tre (2)
Meet Benjamin Franklin - Scarf, Maggi, B92 Fra (3)

## AUDIO-VISUALS

Note: Many of the materials listed can be used at both primary and intermediate grade levels. The figure either P (Primary level K-3), I (Intermediate Level 4-6), or P&I (both levels) has been placed there as a recommendation that it be used at that particular grade level.

Films:

What Makes Rain, 551.57 (P)
Sparky, The Colt, 591.5 Spar (P)
Animals of the Zoo, 591.5 An (P)
Robin Redbreast, 598.2 Rob (P)

Black Bear Twins, 591.5 Bla (P)
Simple Machines, 621.8 (P&I)

Filmstrips:

Noah and the Ark, 221 Noa (P)
The Solder System, 523.2 Sol (P&I)
What Are Stars, 523.8 Wha (P&I)
Winter Has Two Faces, 525a Wint (P&I)
Our Home, The Earth, 525d Our (P&I)
Fall Adventures, 525.1d Sea (P)
Spring Adventures, 525.1e Sea (P)
Summer Adventures, 525.1f Sea (P)
Winter Adventures, 525.1g Sea (P)
Changing Seasons, 525.5 Chang (P&I)
Air, 555f Ear (P&I)
Finding Out About Heating Solids, Liquids and Gases, 536 Find (P&I)
Electromagnets, 537 (P&I)
The Story of Mountains, 551b (P&I)
The Story of Rivers, 551a Ear (P&I)
The World of Living Things, 574 Wor (P&I)
How a Plant Makes Food, 580b How (P&I)
How a Plant Grows, 580 How (P&I)
Plant: Flowers and Fruits, 580 ab (P&I)
Plant: Roots of Plants, 580 ac (P&I)
Plant: Stems of Plants, 580 ad (P&I)
How Plants Live and Grow, 581c How (P)
How Animals Live, 590 How (P)
How Animals Live, 590 How (P&I)
Animals and Seasons (land and water migration), 591c Ani (P&I)
Animal Environment (how animals live in the desert), 591c Ani (P&I)
Common Animals of the Woods, 595d Ani (P&I)
Elephants, 595e Ani(P&I)
Squirrels, 595f Ani (P&I)
Animal Environment (how animals live in the artic), 591d Ani (P&I)
Animal Protection (body covering), 591e Ani (P)
Black Bear Twins, 591.5a Bla (P)
Insects: What They Are, 595.7c Ins (P&I)
Social Insects, 595.7d (P)
Some Different Kinds of Insects, 595.7e Ins (P&I)
What Is An Insect, 595.7 Ins (P&I)
Amphibians, 598.1a Cla (P&I)
Crocodiles and Lizards, 598.1b Cla (P&I)
Turtles, 598.1c Cla (P&I)
Snakes, 598.1d Cla (P&I)
The Migration of Birds, 598.2a (P&I)
Melvin Otter, 599 Ani (P)
Billy Beaver, 599c Ani (P)
Jimmy Raccoon, 599d Ani (P)
Needles Porcupine, 599e Ani (P)
Machines and Tools to Help Us Work, 621.9 Mach (P)
Nothing Can Live Without Water, 628.1 Not (P&I)
Natural Resources: Coal, Oil, Natural Gas, 665.3 Pet (P&I)
Walt Disney's Space and the Atom, FS 629.4w (filmstrip set) (P&I)
Man Learns to Fly
Man and the Moon
Flight Into Space
Man in Space

Man in Flight
Flight Around the Moon
Flight to Mars
Man Discovers the Atom
Our Friend the Atom
Man Becomes an Astronomer

Plants Around Us, 580 (filmstrip set - short strip) (P&I)
# 1 - Different Kinds of Plants
# 2 - Where Plants Grow
# 3 - Many Plants Are Green
# 4 - Some Things Green Plants Need
# 5 - Parts of a Flower Plant
# 6 - What Are Flowers
# 7 - What Are Fruits
# 8 - How a Bean Seed Grows
# 9 - How Seed Plants Start Growing
#10 - How to Know Trees
#11 - How We Use Plants
#12 - Food From Plants

Exploring With Science, 500 Exp (filmstrip set - whort strip) (P&I)
# 1 - Old Mother Sun
# 2 - Our Planet Earth
# 3 - You and the Universe
# 4 - Seasons Come and Go
# 5 - What Day Is It
# 6 - When Night Comes
# 7 - What is Weather
# 8 - Power Moves Things
# 9 - Meet the Plant Family
#10 - Meet the Animal Family
#11 - Meet the Human Family
#12 - You Are Alive

Why of Elementary Science, 621 (filmstrip set) (P&I)
Simple Machines
# 1 - How Wheels Help Us
# 2 - How Levers Help Us
# 3 - How Ramps and Screws Help Us
# 4 - How Wedges Help Us

Fundamentals of Science, 500 fun (filmstrip set) (P&I)
# 1 - Earth & Soil
# 2 - Our Changing Earth
# 3 - Gravity, Inertia and Friction
# 4 - Electricity and Magnetism
# 5 - Sound
# 6 - Neighbors In Space
# 7 - Light
# 8 - Atoms and Atomic Energy - I
# 9 - Matter and Molecules - I
#10 - Light and Color

Physical Science, 520 (filmstrip set) (P&I)
Oceans, 551.4
Rocks and Minerals, 543
Moon, Sun and Stars, 520
Deserts, 551.4
Seasons, 525
Air Around Us, 533

Biological Science, 598.1 (filmstrip set) (P&I)
- Dinosaurs, 568
- Pets, 636
- Farm Animals, 636
- Reptiles, 598.1
- Tropical Fishes, 597
- Your Body and You, 612

Natural Science, 500 (filmstrip set) (P&I)
- Trees, 582
- Birds We Know, 598
- Insects, 595.7
- Animals of Sea and Shore, 590
- Animal Babies, 590
- Plants We Know, 580

Different Kinds of Animals, FS 590 D (filmstrip set) (P&I)
- # 1 - Some Water Animals
- # 2 - Mammals
- # 3 - Birds
- # 4 - Amphibians
- # 5 - Reptiles
- # 6 - Insects

Earth, 550 (filmstrip set) (P&I)
- A Story of Our Earth: Rocks and Soil, 550
- The Ice Age, 551.7
- Coal-A Fossil Fuel, 549
- How Crystals Are Formed, 548
- The Story of Mountains, 550

Birds and Their Songs, 598 Bir (filmstrip and records) (P&I)
- Part 1
- Part 2
- Part 3
- Part 4

Plants and Their Environment, 580 (filmstrip and records) (P&I)
- # 1 - Flowers Transfer Pollen
- # 2 - How Plants Use Leaves
- # 3 - How Seeds and Fruits Travel
- # 4 - How Plants Use Other Plants

Filmloops:

Bighorn Sheep, 591 Big (P&I)
Fawn Deceives Mountain Lion, 591 Faw (P&I)
Coyote, 591 Coy (P&I)
How Spiders Capture Prey-Spiders with Webs, 595.4 How (P&I)
How Spiders Capture Prey-Spiders without Webs, 595.7 Spi (P&I)
Seed Dispersal, 581 See (P&I)
Self-Planting Seeds, 581 Sel (P&I)
Cheetah Hunting Food, 590 Chee (P&I)
Scavengers of Africa, 590 Sca (P&I)
Water Animals Hunting Food, 590 Wat (P&I)
Salmon Run, 567 Sal (P&I)
What is a Mammal, 599 Wha (P&I)
The Gerbil, 599 Ger (P&I)
Brown Bear Diet, 599 Bea (P&I)
Common American Birds (habits), 598.2 Com (P&I)
Common American Birds (nest and young), 598.2 Bir (P&I)
Rattlesnake, 598.1 Rat (P&I)
Birds Building Nests, 598 Bir (P&I)

Sheep Ranching, 630.1 She (P&I)
Logging, 634.9 Log (P&I)
Eskimo Seal Hunt, 919.8 Esk (P&I)

Slides:

Snake (Copperhead), 568 Sna (P&I)
Crayfish, 595 Cra (P&I)
Frogs, 597 Fro (P&I)
Lizard, 598.1 Liz (P&I)
Eye, 611 Eye (P&I)
Denver Zoo and Gardens (10 slides) (P&I)
Rocks, 552 Roc (P&I)

Transparencies:

The Universe: Solar System, 523.2 Sol Trans (P&I)
Weather, 551.5 Wea Trans (P)
Plants: Parts of a Plant, 580 Pla Trans (P&I)
Plants: Parts of a Flower, 581 Flo Trans (P&I)
Housefly, Life Cycle, 595.7 Hou Trans (P&I)
Insects: Characteristics, 595.7 Ins Trans (P&I)
Life Cycle: The Beehive, 595.7 Bee Trans (P&I)
Housefly: Characteristics, 595.7 Hou Trans (P&I)
Life Cycle of the Butterfly, 595.7 But Trans (P&I)
Mammal Characteristics, 596 Mam Trans (P&I)
Mosquito: Life History, 595.7 Life Trans (P&I)
Mosquito, 595.7 Mos Trans (P&I)
Mosquito: Life Cycle, 595.7 Mos Trans (P&I)
Life Cycle: The Ant Colony, 596 Ant Trans (P&I)
Intelligence of Animals, 596 Int Trans (P&I)
Life Span of Animals, 596 Lif Trans (I)
Amphibians: Characteristics, 597 Amph Trans (P&I)
Vertebrates: Characteristics, 596 Vert Trans (P&I)
Fishes and Amphibians, 597 Fis Trans (P&I)
Fishes: Characteristics, 597 Fis Trans (P&I)
Fishes: Characteristics, 597 Fis Trans (P&I Duplicate)
Frog: Life Cycle, 597 Frog Trans (P&I)
Birds and Reptiles, 598 Bir Trans (P&I)
Birds: Characteristics, 598 Bir Trans (P&I)
Animals Without Backbones, 598.1 Ani Trans, (P&I)
Reptiles: Characteristics, 598.1 Rep Trans (P&I)
Mammals: Characteristics, 599 Mam Trans (P&I)
The First Class Level, 621 Fir Trans (P&I)

Charts and Pictures:

Birds (P&I)
Transportation (P&I)
City Life/Farm Life, 323.35 (P)
Understanding Our Weather, 551.59 Und (P&I)
Life In The Sea, 591.92 Lif (P&I)
Animals Without Backbones, 592 (P&I)
Wild Animals, 591.5 (P&I)
Reptiles and Amphibians, 598.1 (P&I)
Moths and Butterflies, 595.78 (P&I)
Common Insects, Group 1, 595.7 (P&I)
Common Birds, Group 1, 598.2 (P&I)

Work and Machines, 621 (P&I)
Simple Machines, 621.9 Sim (P&I)
The Eye, 612 Eye (P&I)
Seasons, 525 Sea (P)
Weather Charts, 551.5 Wea (P&I)
Color Chart, 535 Col (P)
Biology (parts of a plant, insect, bird), 570 (P&I)
The Wheel, 531 Whe (P)
Earth and Sky, 525 Ear (P)
Earth, 525 (P)
Oceanology, 551.4 (P&I)
Matter and Energy, 531 (P&I)
Electricity and Magnetism, 537.2 (P&I)
Heat, Light and Sound, 531 (P&I)
Gravity and Other Forces, 521 (P&I)
Nature and Science - How Seeds Get Around, 580 (P&I)
Plants, 580 (P&I)
Deer, 599.5 (P&I)
Frog - 1, 570 Mar (P&I)
Fish - 2, 570 Mar (P&I)
Turtle - 3, 570 Mar (P&I)

Records:

A Walk in the Forest, 398.2 S229 (P)
My Playmate, The Wind, 398.2 S232 (P)
By Rocket to the Moon, 523.3 S227 (P)
Jungle Animals, E Jun (P)
Let's Play Zoo, 594 S218 (P)
Children's Stories and Songs (snail, duck, woodpecker), Sc Chi (P)
Listening Time (Seashells, Shadow), Sc List II (P)
Noah's Ark, Sc Noa (P)
Sounds Around the House, Sc Sound (P)
Stories in Sound, 152 Stor (P)
Space Songs, 530.1 Gla (P&I)
Weather Songs, 551.59 Gla (P&I)
Nature Songs, 574 (P&I)
Poetry: The First Snowfall; To a Waterfowl, 810 Poe (P&I)
Rain Storm: Wind Howling (sound effects records), 812 Rain (P)
Singing Science Sampler From Ballads for the Age of Science (insect, conservation, gravity, etc.), 500 (P&I)
Out-Of-Doors, 784 Out (P)
I Am the Wind, 784 A140 (P)
Tom Glazer: Weather Songs - Packet C, 551.59 (P&I)

Tapes:

Magic Road of Sounds, 411 Mag (P&I)
Stories in Season - Spring & Summer, Sc Stor (P&I)
Stories in Season - Fall & Winter, Sc Stor (P&I)
Noise and Musical Notes, 780 Noi (P&I)

Kits:

Science Treasure Chest, Set #1, Set #2, 500 Sci (P&I)
Seeds (flannel board aids), 581 See (P&I)
Boxed Set Shells, 594 Shel (P&I)
Fundamentals of Sound, 534 Fund (P&I)

Plant Growth, 580 Pla (P&I)
Plants and Goods (Instructo flannel board), 580 Pla (P&I)
Seasons and Weather, 551 Sea (P)
Animal Classification, 591 Ani (P)

Models:

Radiometer, A Solar Engine, 523.7 Rad (P&I)
Chick Egg Incubator, 598 Chi (P&I)
Junior Turn-A-Gear, 621 Boxed Set (P&I)
Lever, 621.9 Lev (P&I)
Screw, 621.9 Scr (P&I)
Solar System, 523.2 Solar (P&I)
Universal Planetarium, 523.2 Solar (P&I)
Gear, 621.9 Ful (P&I)
Fulcrum Balance, 621.9 Ful (P&I)
Wheel and Exle, 621.9 Whe (P&I)
Inclined Plane, 621.9 Inc (P&I)
A Gear Train, 621.9 Gear (P&I)

Equipment:

Giant Magnifier, 500 Equip (P&I)
Miscellaneous Microscopes
Weather Vanes
Weather Check: Calibrated Official Set 1 & 2, 551.5 (P&I)

Specimen:

Specimen Fascinating Mineral, 552 Rec (P&I)
Specimens of Frog, Clam, Fish, Starfish (P&I)

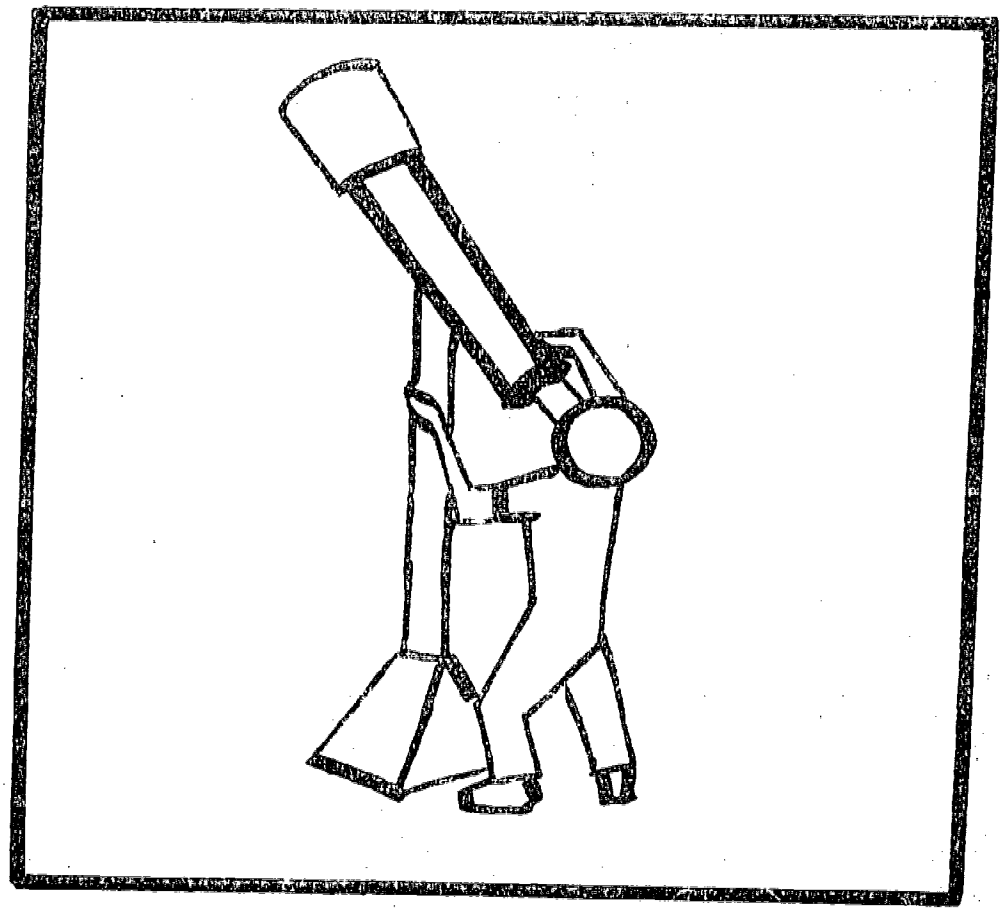
Games:

Curtis Martin - The Story of Shells, 594 Game She (P&I)
The Earth and Its M-on (flannel board aids), 523.1 game (P&I)
Science Quizzer, 500 Sci (P&I)

Vertical File: (P&I)

Alphabetically arranged pamphlets, booklets, etc.:

Aluminum
Atomic Energy
Birds
The Body
Butterflies
Coal
Conservation
Copper
Dinosaurs
Ecology
Fossils
Frogs
Inventions
Machines, Tools
Moon
Nature Study
Oceans
Oil Industry
Power
Reptiles
Rocks
Science Experiments
Science Measurements
Space
Trees
Turtles
Weather
Water
World Around You



# THE UNIVERSE

GRADES FOUR THROUGH SIX

GENERAL SCIENCE

I. Develop an understanding of plants and animals.

Objective: Each student should have the opportunity to be able to understand and appreciate the interdependence and the changes that occur among things with their environment.

| LEVEL | | |
|---|---|---|
| | A. | Chemistry of Living Things |
| 4 | 1. | Each student will be able to explain or describe that the basic food substance for energy for living things is sugar. |
| 5 | 2. | Each student will be able to describe how an enzyme works. |
| 5 | 3. | Each student will be able to relate that energy is transferred in a living cell through a compound called ATP. |
| 5 | 4. | Each student will be able to explain chemically the process of basic respiration (e.g., food (sugar) + oxygen = energy for action and building + $CO_2$ & $H_2O$). |
| 5 | 5. | Each student will be able to list the three nutrient compounds that are found in food which are fats, carbohydrates and proteins, and identify their major elements that make these up (i.e., carbon, hydrogen, oxygen and nitrogen). |
| 6 | 6. | Each student will be able to investigate and explain that enzymes cause chemical changes which aid in many body processes (e.g., diastase and breakdown of starch). |
| | B. | Functioning of the Body |
| 5 | 1. | Each student will be able to describe the organization of the body parts and how they work together to accomplish the life function (e.g., the interdependence of cells, tissues, organs and systems). |
| 5 | 2. | Each student will be able to explain the inter-relationship between structure and functions of the systems that maintain life (i.e., circularoty, respiratory, excretory, digestive, muscular and nervous). |
| 5 | 3. | Each student will be able to describe that the cell is the basic unit of structure and function of all living things. |
| 5 | 4. | Each student will be able to deduce that all cells in living things come from other cells (e.g., mitosis, cell division). |
| 5 | 5. | See Geology II-B-1. |
| 6 | 6. | Each student will be able to conclude that living organisms have structures which function in response to stimuli from the environment. |
| 6 | 7. | See Chemistry of Living Things I-A-2. |
| 6 | 8. | Each student will be able to specify through learned behavior patterns that an organism is capable to change his environment. |
| | C. | Energy and Photosynthesis |
| 4 | 1. | Each student will be able to conclude that the sun is the source of energy for photosynthesis. |
| 4 | 2. | Each student will be able to identify that soil, air and water are the sources of raw material for photosynthesis. |
| 5 | 3. | Each student will be able to express that the green coloring matter in plants is chlorophyll and that it is necessary in the process of photosynthesis. |

5 4. Each student will be able to explain that the energy from sunlight is transformed to stored energy as food by the process of photosynthesis.

D. Ecology

4 1. Each student will be able to explain that there is an interchange of matter between living things and their environment (e.g., plants, converting to $CO_2$ and $H_2O$ to food and then these two substances being returned when food is used).

4 2. Each student will be able to determine how living things are dependent upon the environment they live in (e.g., growing plants leaving out one of the factors such as air, light, water, etc.).

4 3. Each student will be able to explain that microrganisms return matter to the environment (e.g., growth of bacteria, mushrooms, and other fungi).

4 4. Each student will be able to conclude that there are special structures that enable organisms to survive within their particular environment (e.g., tubes, gills, roots).

4 5. See Matter IV-A-6.

5 6. Each student will be able to explain that the cell is the basic unit of all living things and interchanges matter and energy with the environment.

5 7. Each student will be able to compare single-celled organisms with multicellular organisms seeing the great similarities with the interrelationship to the environment.

5 8. Each student will be able to explain that non-green plants are not capable of producing their own food and therefore are dependent upon their environment.

5 9. See Geology II-B-2.

6 10. Each student will be able to deduce that man through his development of culture and technology is able to change and control his environment.

6 11. See Geology and Matter.

6 12. Each student will be able to demonstrate by simple experimentation that behavior patterns are both simple and complex as well as voluntary and involuntary through changes in the environment.

6 13. See Hereditary I-E-5.

E. Heredity and Development

4 1. Each student will be able to deduce that the formation of the embryo in plants and animals is similar.

5 2. Each student will be able to explain that cells, in reproducing themselves, pass along the hereditary patterns through chromosomes with their DNA content.

5 3. Each student will discover growth occurs in many-celled organisms by the multiplication and differentiation of cells.

5 4. See Functioning I-B-4.

6 5. Each student will be able to conclude that the animal's life cycle is adapted to its environment.

6 6. Each student will be able to explain that DNA is a large molecule that carries in its structure the code that determines the inherited traits.

6 7. Each student will be able to describe the simple structure of DNA.

6 8. Each student will be able to observe and describe the ways genes interact to cause pure, hybrid, or blended traits.

9. Each student will be able to describe how plants and animals can be improved upon by selective breeding.

LEVEL

6 10. Each student will acquaint himself with the idea that the characteristics of living things are laid down in a genetic code.
6 11. Each student will be able to explain that when the genetic code is changed this causes changes in living things.

II. Develop an understanding of geology as a science.

Objective: Each student should have the opportunity to understand and appreciate the changing environment of the earth, as evidenced by the fossil records and geological forces.

A. Geological Forces

4 1. Each student will be able to observe the breaking down of the earth's surface by erosion (e.g., water, wind, freezing, heat).
4 2. Each student will discover the relationship of sedimentation and mountain building.
5 3. Each student will be able to investigate the formation of sedimentary, igneous and metamorphic rock (Cross reference water).
5 4. Each student will be able to identify the forces that cause uplift on the earth.

B. Fossil Records

5 1. Each student will be able to relate the structure and function of fossil bones with those of today's living animals.
5 2. Each student will acquaint himself with the idea that through environment adaptations, our present-day mammals have evolved from ancient one-celled sea animals.

III. Develop a knowledge of astronomy and meterology.

Objective: Each student should be able to recognize that the universe is in constant change.

A. Solar System

4 1. Each student will be able to observe that the moon and comets have definite and predictable orbits caused by gravity.
2. Each student will be able to observe that meteors, which are fragments of larger bodies, do not have definite and predictable orbits.

B. Universe

5 1. Each student will be able to explain the use and the theory of an astronomer's tools (e.g., telescopes).
5 2. Each student will be able to explain the theory of light.
5 3. Each student will be able to discover that distances in space are measured in light years.
6 4. Each student will be able to explain that a star's energy is due to a nuclear reaction.
6 5. Each student will be able to relate how size and temperature of a star is determined.
6 6. Each student will be able to relate some methods of determining the size of the universe.
6 7. Each student will be able to explain the life cycle of a star.
6 8. Each student will be able to determine that stars have motion (e.g., Doppler Effect).

C. Weather

4 1. Each student will be able to investigate and relate the causes of weather.
5 2. Each student will be able to explain and use the tools of the meteorologists.
5 3. Each student will be able to observe and describe the various cloud formations.
6 4. Each student will be able to relate that atmosphere influences weather.
6 5. Each student will be able to conclude and explain that climate is the average weather for a region over a long period of time.

IV. Develop the role that matter has in science.

Objective: Each student should have the opportunity to realize that matter is made up of tiny particles having different arrangements and matter can undergo both physical and chemical changes. When these changes occur, the total amount of matter remains unchanged.

A. Water

4 1. Each student will be able to observe that water vapor enters the air when heat energy is added (e.g., cloud formation).
4 2. Each student will be able to observe that water vapor leaves the air when there is a loss of heat energy (e.g., rain).
4 3. Each student will be able to explain that in a mixture of warm and cold water, the warm water will rise and the cold water will sink due to contraction and expansion.
4 4. Each student will be able to explain that ocean currents are the result of unequal heating of water and air.
4 5. Each student will be able to explain that the water cycle is the result of evaporation and condensation.
4 6. Each student will be able to derive that the water cycle provides the water necessary to maintain and change the physical and living environment.
4 7. See Energy V-D-1.

B. Air

4 1. Each student will be able to observe that air as matter is made up of various gases.
4 2. Each student will be able to investigate that air occupies space and exerts pressure.
4 3. Each student will be able to relate some of the useful purposes of the gases in air.
4 4. Each student will be able to explain the oxygen cycle and its relationship to living things and the environment.
5 5. Each student will be able to identify various sources of $CO_2$ and test for its pressure.
5 6. See V-D-1.

C. Molecules

4 1. Each student will be able to observe that elements have recognizeable properties.
4 2. Each student will be able to investigate an element that is made up of one kind of atom and a compound that is made of more than one element.

4 3. Each student will be able to investigate that when molecules interact, compounds are formed.
5 4. Each student will be able to conclude that when physical and chemical changes occur, the total amount of matter remains unchanged.
5 5. Each student will be able to conclude that the basic unit of a compound is the element; the compound can be broken down or built up from elements chemically.
5 6. Each student will be able to observe that compounds may be grouped by their chemical properties (e.g., testing acids and bases with litmus paper).
5 7. Each student will be able to explain that elements, compounds and mixtures are made up of atoms combined in different ways.
5 8. Each student will be able to explain that atoms make up molecules.
6 9. Each student will be able to explain that atoms consist of various particules arranged in their own characteristic structure.

V. Develop a basic understanding of energy.

Objective: Each student should be given the opportunity to be able to recognize different forms of energy and understand that though forms can be changed from one to another the amount of energy remains unchanged.

A. Sound

4 1. Each student will be able to investigate that the pitch of sound depends on the rate of vibration.
4 2. Each student will be able to investigate sound traveling in waves by molecular motion.
4 3. Each student will be able to investigate how sound travels in two states of matter (e.g., olid and gas).
4 4. Each student will be able to investigate that sound can bounce off or be absorbed by material.
4-5 5. Each student will be able to investigate that sound is caused by vibrating objects (e.g., drum strings (4th) and telephones (5th)).

B. Light

4 1. Each student will be able to investigate that other forms of energy may be changed to light energy (e.g., burning candle).
4 2. See Photoshythesis I-C-1.
4 3. See Photosynthesis I-C-4.
4 4. Each student will be able to investigate that light can be absorbed (e.g., black paper).
4-5 5. Each student will be able to investigate that light can be reflected (e.g., mirror (4th) and telescope (5th)).
4-5 6. Each student will be able to investigate and explain that light can travel through space in a straight line (e.g., bent tube (4th) and periscope (5th)).
4-5 7. Each student will be able to investigate and explain that light may be bent as it passes through certain material (e.g., convex lens, water (4th) and prism (5th)).
4-5 8. Each student will be able to investigate that light energy behaves sometimes as waves (e.g., polarized discs (4th) and wave lengths vs color (5th)).
5 9. Each student will be able to investigate that light energy behaves sometimes as particles (e.g., light meter).
10. Each student will be able to observe light can be broken into a spectrum of colors as its passes through a prism.

| | | |
|---|---|---|
| 5 | 11. | See Ecology I-D-5. |
| 5 | 12. | See Astronomy III-B-3. |

C. Machines

| | | |
|---|---|---|
| 5 | 1. | See Chemistry of Living Things I-A-3. |
| 6 | 2. | Each student will be able to investigate and describe how machines may multiply force, increase speed, or change direction (e.g., fixed pulley, lever, wheel and axle, inclined plane). |
| 6 | 3. | Each student will be able to measure and compute mechanical advantage of a simple lever and system of pulleys. |
| 6 | 4. | Each student will be able to investigate and describe that compound machines are a make up of simple machines. |
| 6 | 5. | Each student will be able to investigate that friction is a force that resists motion. |
| 6 | 6. | Each student will be able to investigate relationships and derive an equation for work (e.g., work=forcexdistance). |
| 6 | 7. | Each student will be able to investigate and explain that the amount of energy obtained from a machine does not exceed the energy put into it. |

D. Motion

| | | |
|---|---|---|
| 5-6 | 1. | Each student will be able to relate Newton's 3rd Law as applying to rockets. |
| 6 | 2. | Each student will be able to explain that the energy of moving molecules of air and water provide a force that can be harnessed to do work (e.g., steam engine). |
| 6 | 3. | Each student will be able to investigate and explain that molecules may be given kinetic energy in a chemical change (e.g., combustion). |
| 6 | 4. | Each student will be able to describe that difference in pressure causes a force to act in the direction of the lower pressure (e.g., lift on an airplane wing). |
| 6 | 5. | Each student will be able to infer from examples that potential energy and kinetic energy are inter-changeable (e.g., burning fuel, steam engine and auto engine). |

E. Gravity

| | | |
|---|---|---|
| 5 | 1. | Each student will be able to demonstrate the force of gravity (e.g., toss a ball). |
| 5 | 2. | Each student will be able to explain the difference between weight and mass. |
| 5 | 3. | Each student will be able to investigate and explain the law of inertia. |
| 5. | 4. | See Solar System III-A-1. |

F. Electricity

| | | |
|---|---|---|
| 6 | 1. | Each student will be able to explain how electricity can be used to extract metal from ore. |
| 6 | 2. | Each student will be able to build a simple electrical device and explain how it functions (e.g., electric bell, electric motor, telegraph, telephone or electroscope). |
| 6 | 3. | Each student will be able to demonstrate that static electricity is stored energy and current electricity is kinetic energy). |
| 6 | 4. | Each student will be able to explain how an electric current can be generated (e.g., hand generator, hydroelectric generator). |

6 5. Each student will be able to explain how electric energy can be changed to electromagnetic waves that can carry signals through space (e.g., radio, TV).

G. Heat

6 1. Each student will be able to investigate and explain that heat is the kinetic energy of molecules.
6 2. Each student will be able to investigate and describe the nature of heat (e.g., how heat is transmitted and how heat changes the state of matter).

H. Nuclear

6 1. Each student will be able to relate that nuclear energy is released when the nucleus of an atom is split or changed.
6 2. Each student will be able to describe some methods that can bring about fission (e.g., nuclear reaction, cyclotron).
6 3. Each student will be able to list some useful applications of nuclear energy (e.g., power plants, radiation treatment).
6 4. See Solar System III-B-4.
6 5. Each student will be able to relate that nuclear energy can be obtained from atom fission or fusion (e.g., H-bomb, energy from the sun).

INTERMEDIATE RESOURCES 4-6:

PLANTS AND ANIMALS

Chemistry of Living Things

How to Build a Body - May, Julion, 574.8 May (4-6)
The Wonderful World of Food - Boyd, Orr, 641.3 (4-6)

Functioning of the Body

What's Inside of Animals - Zim, Herbert, 591.1 Zim (4-6)
Your Eyes - Adler, Irving & Ruth, 612 Adl (4-6)
How We Hear - Fryer, Judith, 612.85 (4-6)
Blood - Zim, Herbert S., 612 Z (4-6)
Our Wonderful Eyes - Perry, John, 612 Per (4-6)
Human Physiology - Morrison, Thomas F., 612 Mor (4-6)
Wonders of the Human Body - Ravielle, 611 Rav (4-6)
Our Wonderful Hands - Krishel, Robert, 611 Kri (4-6)
Fission - Rainwater, Jeanette, 621 Rai (4-6)
The Strange World of Animal Senses - Cosgrove, Margaret, 591 C (4-6)
Wapiti, King of the Woodland - Peterson, Willis, 590 Pet (4-6)
Water Animals for You - Lindeman, Edward, 592 Lin (4-6)
Lifeline - Schneider, Leo, 612.1 Sch (4-6)
The Story of Your Blood - Weart, Edith, 612.11 Wea (4-6)
The Story of Your Resperation System - Wearth, Edith, 612.2 Wea (4-6)
How Your Body Works - Schneider, 612 Sch (4-6)
All About the Human Body - Glemser, 612 Gle (4-6)
Understanding Your Body - Blockman, Laurena Y., 612 Blo (4-6)
Your Ears - Adler, Irving, 612.85 Adl (4-6)
The Story of Your Brain Nerves - Weart, Edith, 612 Wea (4-6)
Hear Your Heart - Shower, Paul, 612 S (4-6)
Your Brain, Master Computer - Hyde, Margaret O., 612 Hyd (4-6)
Understanding Your Senses - Gilmoore, Ann Boyce, 612 Gil (4-6)

Ecology

The Strange Companions - Earle, Olive L., 591.5 Ear (4-6)
Microbes at Work - Selsam, Millicent, 589.9 Sel (4-6)
Junior Science Book of Bacteria - Lietz, Gerald S., 589.9 Lietz (4-6)
The Wonders of Algae - Kavaler, Lucy, 589.3 (4-6)
The Wonders of Fungi - Kavaler, Lucy, 589 Kav (4-6)
Vanishing Animal - Street, Philip, 639.9 Str (4-6)
Downstream: A Natural History of the River - Bardach, John E., 574.929 Bar (4-6)
Your World - Your Survival - Warner, Matt, 574.5 W (4-6)
Our Environment in Relation to Us - Smith, Paul, 581.5 Smi (4-6)
The First Book of Wildlife Sanctuaries - Harrison, William, 333.8 Har (4-6)
Conservation and You - Hitch, Allen, 333.7 Hit (4-6)
The First Book of Conservation - Smith, Francis, 333.7 Smi (4-6)
Rain, Rivers & Reservoirs - Archer, Sellers, 333.9 Archer (4-6)
Water at Work - Meyer, Jerome, 333.9 Mey (4-6)
Out Doors - Johnson, Mat, 333.7 Joh (4-6)
Please Protect the Porcupine - Hazen, Barbara, 333.7 Haze (4-6)
The Desert Water Hole - Church, Jeffrey, 591 Chu (4-6)

Heredity and Development

The Story of Man - Jacobson, Daniel, 572 J (4-6)
Egg to Chick - Selsam, Millicent, 591.3 (4-6)
The Courtship of Animals - Selsam, Millicent, 591 Sel (4-6)
Millions of Years of Eggs - May, Julian, 591 May (4-6)
Horses: How They Came to Be - May, Julian, 636.1 M (4-6)
What's Inside of Plants? - Zim, 581 Zim (4-6)
Bits That Grow Big - Web, 581 Web (4-6)
How Plants Grow - Neurath, Maria, 581 (4-6)
Wonders of Seeds - Stefferid, 581 Ste (4-6)
Play With Seeds - Selson, 581 Sel (4-6)
A Fruit is Born - Guilcher, J. M., 581 Gui (4-6)
A Tree is Born - Guilcher, J. M., 582 Gui (4-6)
All About Us - Knox, Eva, 572 Eva (4-6)
A New Baby Comes - May, Mulian, 612.6 May (4-6)
The Story of a Baby - Ets, Marie Hull, 612.6 Ets (4-6)
The Wonderful Story of How You Were Born - Gruenberg, S., 612.6 Gru (4-6)
An Ant is Born - Doering, 595.7 Doe (4-6)
A Bee Is Born - Doering, Harold, 595.7 Doe (4-6)
All About Heredity - Randul, Judith, 575.1 Ran (4-6)
Do You Have Your Father's Nose - May, Julian, 575.1 May (4-6)
The Stuff of Life: How Heredity Works - Clare, J., 575.1 Cla (4-6)
What is a Cell? - King, 574.8 Kin (4-6)
Birth of a Forest - Selsam, Millicent, 574.5 Sel (4-6)
Horses of Long Ago - Ipcar, Dahloo, 636.1 Ipc (4-6)
Wonderful Egg - Schloat, G. Warren, 636.5 (4-6)
Roses and People - Boyd, William Clouser, 572.3 Boy (4-6)
From Fins to Hands - Ravielle, Anthony, 573.2 R (4-6)
The Adventure of Man - Greyor, Arthur, 573.2 Gre (4-6)
Monarch Butterfly - Marcher, 595.7 Mar (4-6)
True Book of Honeybees - Leweller, 595.7 Lew (4-6)
This Is A Flower - Hutchins, Ross, 582.1 Hut (4-6)

General Classification

Winter - Sleeping Wildlife - Barker, Wi-1, 591.543 Bar (4-6)

Along the Seashore - Buck, Margaret, 591.92 Buc (4-6)
A Field Guide to Animal Tracks - Murie, Olaus Johan, 591.49 (4-6)
Animal Clothing - Mason, George Federick, 491.49 Mas (4-6)
Animal Tools - Mason, George, 491.49 (4-6)
About Penguins - Harmer, Mabel, 591.9 (4-6)
Horay - Emery, Carolyn, 591.9 E (4-6)
The Language of Animals - Selsame, Millicent, 591.5 Sil (4-6)
The Last of the Sea Otters - McCraken, Harold, 591.5 McC (4-6)
Animal Teeth - Mason, George, 591.4 Mas (4-6)
Men, Arts & Elephants - Weyl, Peter, 591 Wey (4-6)
The Bird Kingdom - 598.2 Bir (4-6)
Familiar Reptiles and Amphibians of America - Barker, Will, 5981. Bar (4-6)
All About Snakes - Hecht, Bessir M., 598.1 Hec (4-6)
Animals in Armor - Hylander, Clarence John, 598.1 (4-6)
A Guide to the Most Familiar American Birds, Zim, Herbert S., 598 (4-6)
Reptiles and Amphibians - Zim, Berbert, 598.1 Zim (4-6)
A Turtle in the House - Navarra, John Gabriel, 598.1 N (4-6)
First Book of Snakes - Hoke, 598.1 Hok (4-6)
Bird Nests - Shakelford, Nina, 598 Sha (4-6
Wild Wings - Hendrickson, Walter B., 598 H (4-6)
Birds and Their Nests - Earle, Olive L., 598.2 Ear (4-6)
What Makes a Bird a Bird - Garelick, May, 598 Gar (4-6)
Birds - Zim, 598 Zim (4-6)
The True Book of Animals Homes - Podendorf, 591 Pod (4-6)
Animal Homes - Mason, 591 Mas (4-6)
Animals - Seton, 591.5 Set (4-6)
Animal Weapons - Mason, George, 591.57 (4-6)
Animal Sounds - Mason, George, 591.59 (4-6)
Animal Homes - Mason, George, 591.57 Mas (4-6)
Life in the Arctic - Holsaert, Eunice, 919.8 H (4-6)
Animals of the Far North - May, Charles, 591.9 May (4-6)
Beginner's Guide to Fresh Water Life - Hausman, 591.929 (4-6)
Familiar Animals of America - Barker, Will, 591.97 (4-6)
Junior Science Book of Seashells - Epstein, Samual, 594 Eps (4-6)
Houses From the Sea - Goudey, Alice E., 594 Gou (4-6)
Spiders and How They Live - David, 595 Dav (4-6)
Spider Silk - Goldin, Augusta, 595 Gol (4-6)
Box Turtle Lives in Armor - May, Charles Paul, 598.13 (4-6)
Snakes - Zim, Herbert S., 598.1 (4-6)
Birds - Blanchan, 598 Bla (4-6)
A Field Guide to Western Birds - Peterson, Roger Tory, 598 Pet (4-6)
The American Horse - Nagler, Barney, 636.1 Nag (4-6)
Animals That Work for Man - Sander, Lenore, 636 (4-6)
First Book of Horses - McMeekin, McLennen, 636 McM (4-6)
A Zoo for You - Lubell, Winifred, 636 L (4-6)
Animals That Help Us - Fenton, Carroll, 636 Fen (4-6)
Pets - Chrystie, Frances N., 636 Chr (4-6)
The Wonderful World of Plants and Flowers, 581 Swi (4-6)
Plants We Eat - Selson, 531 Sel (4-6)
Plants That Move - Selson, 581 Sel (4-6)
Plant Life - Milne, Lorus, 581 Mil (4-6)
Plants That Feed Us - Fenton, Carroll Lane, 581 Fen (4-6)
This is a Leaf - Mutchins, Ron E., 581 Hut (4-6)
The Strangler Fig and Other Strange Plants - Earle, Olive L., 581.5 E (4-6)
Flora of Montana - Booth, 580.978 Boo (4-6)
The First Book of Trees - Cormack, M. G., 582 Cor (4-6)
Look at a Flower - Aphelia, Anne, 582 Dow (4-6)
A Field Guide to Rocky Mountain Wildflowers - Craighead, John, 582 Cra (4-6)

Field Book of American Trees - Schuyler, Mattews, 582 Mat (4-6)
Book of Trees - Mills, Lewis H., 582 Mil (4-6)
This Is A Tree - Hutchins, Ross, 582 Hut (4-6)
Trees and Their Story - Sterling, Dorothy, 582 Ste (4-6)
The Doubleday First Guide - Watts, May, 582.16 Wat (4-6)
Trees - Zim, Herbert, 582 Zim (4-6)
Flowers - A Guide to Familiar Flowers - Zim & Martin, 582 Zim (4-6)
Flowers - Zim, Herbert, 582.13 Zim (4-6)
Night Rovers: Flying Squirrels and Their Neighbors - Eberle, Irmengarde, 590 Ebe (4-6)
Because of a Tree - Milne, Louis, 582.16 Mil (4-6)
Animals Clocks & Compasses - Hyde, Margaret O., 591 Hyd (4-6)
Everyday Miracle - Eckstein, Gustav, 591 E (4-6)
The Deer Family - Wood, F., 599.7 Woo (4-6)
The Story of a Hippopotamus - Milotte, Alfred, 599.7 Mil (4-6)
Born Free - Adanson, Joy, 599.744 Ada (4-6)
The World of the Black Bear - Van Wormer, Joe, 599 Van (4-6)
Raccoons are the Brightest People - North, Sterling, 599 Nor (4-6)
Wild Dogs - Colby, C. B., 599 Col (4-6)
Wild Cats - Colby, C. B., 599 Col (4-6)
Wild Rodents - Colby, C. B., 599.3 Col (4-6)
The Complete Dog Book - American Kennel Club, 636.7 Ame (4-6)
Man and Mastiff - Kay, Helen, 636.73 Kay (4-6)
Cats - Bronson, 636.8 Bro (4-6)
Song of the Seasons - Webb, 591 Web (4-6)
Wonders of the Wasp's Nest - Lavine, Segmund, 595.7 (4-6)
All About Ants - Larson, Peggs, 595.7 Lar (4-6)
How to Know the Immature Insects - Chu, H. F., 595.7 Chu (4-6)
The Grasshopper Book - Bronson, Wilfrid, 595.7 Bro (4-6)
Moon Moth - Hutchins, Carleen, 595.7 Hut (4-6)
The First Book of Bugs - Williamson, Margaret, 595.7 Wil (4-6)
Insects on Parade - Hylander, Clarena J., 595.7 Hyd (4-6)
Collecting Cocoons - Hussey, 595.7 Hus (4-6)
Hop, Skim & Fly: An Insect Book - Hutchins, Ron E., 595.7 H (4-6)
How To Know the Insects - Jaquis, 595.7 Jaq (4-6)
Grasshoppers & Crickets - Hogner, Dorothy, 595.726 Hog (4-6)
Here Come the Bees - Goudey, Alice, 595.7 Gou (4-6)
Crustaceans - Schmidt, Waldo La Salle, 595.3 Sch (4-6)
Spiders and How They Live - David, Eugene, 595.44 Dav (4-6)
Plant Families: How To Know Them - Jagus, H. E., 530 Jaq (4-6)
First Book of Plants - Dickinson, 580 Dic (4-6)
The Tale of a Pond - Kane, Henry B., 574.929 Kan (4-6)
Junior Science Book of Pond Life - Crosby, Alerondy T., 574.929 Cro (4-6)
Underwater Zoos - Selsam, Millicent E., 574.92 Sel (4-6)
Aquarium Book for Boys and Girls - Margan, Alfred, 574.92 Mar (4-6)
Along the Seashore - Buds, Margaret Warms, 574.92 Buc (4-6)
Quetico Wolf - Oetting, Bob, 599 O (4-6)
Hoof, Claws, and Antlers - McCracken, 599 McC (4-6)
The Deer Family - Mason, 599 Mas (4-6)
Finding Out About Mammals - Davis, 599 Dav (4-6)
Homes and Habits of the Wild - Schmidt, 599 Sch (4-6)
The World of the Beaver - Rue, Leonard, 599.323 Rue (4-6)
Friendly Animals - Schmidt, 599 (4-6)
The Cat Family - Wood, F. Dorothy, 599 W (4-6)
The World of the Coyote - Van Warmer, Joe, 599.8 Van (4-6)
The World of the Raccoon - Rue, Leonard, 599.744 Rue (4-6)
Our Friend the Forest - Lauber, 634.9 Lau (4-6)
Album of Horses - Henry, 636.1 (4-6)

Swans - McCoy, J. J., 598 McC (4-6)
Bird Watchers and Bird Feeders - Blough, Glenn O., 598 Blo (4-6)
Shark! Unpredictable Killer of the Sea - Helm, Thomas, 597.31 (4-6)
All About Fish - Burger, Carl, 597 Bur (4-6)
Wasp Farm - Evans, Howard, 595.798 Eva (4-6)
The Ants - Goetsch, Wilhelm, 595.796 Goe (4-6)
Insects and the Homes They Build - Sterling, Dorothy, 595.705 (4-6)
The Wonders of Algae - Kavaler, Lucy, 589 Kav (4-6)
State Trees Alive - Earle, Olive, 582.16 Earle (4-6)
Weird and Wonderful Ants - Poole, Lynn, 595.79 Poo (4-6)
Butterflies, Skippers, and Moths - Ayars, James, 595.78 Ayars (4-6)
Six Feet - Whitney, Ruth, 595.7 Whi (4-6)
The Strange Lives of Familiar Insects - Teale, Edwin, 595.7 Tea (4-6)
Beetles - Bronson, Wilfred, 595.76 Bro (4-6)
Butterflies: Tha Nature Library - Weed, Clarence, 595.75 Wee (4-6)
Dragonflies and Damselflies - Phillips, Mary G., 595.733 (4-6)
Birds of the Ocean - Alexander, Wilfred B., 598.292 (4-6)
Graywings - Goudey, Alice E., 598.2 Gou (4-6)
Audubon Land Bird Guide - Pough, Richard H., 598.2 (4-6)
The Audubon Nature Encyclopedia - National Audubon Society, 502 Au (4-6)
Mammals - The Illustrated Encyclopedia of Animal Life, 507.3 Ill (4-6)
Stumpy - Linderman, Frank, 599 Lin (4-6)
Animals of the Arctic - Vevers, Gwynne, 591.998 (4-6)
Corals - Zim, Herbert, 593 Zim (4-6)
Introducing Animals - Bullough, William, 592 Bul (4-6)
Everyday Insects - Allen, Gertrude, 595.7 All (4-6)
Sea Shells of the World - Abbot, Robert, 594 Abb (4-6)
Sea Shells - Dudley, Ruth, 594 Dud (4-6)
Sea Shells - Cavanna, Betty, 594 Ca (4-6)
Wonders of Animal Migration - Berrill, Jacqueline, 591 Ber (4-6)
How to Make a Miniature Zoo - Brown, Vivian, 591 Bro (4-6)
Tropical Rain Forest - Goetz, Delia, 551.4 (4-6)
First Book of Caves - Hamilton, Elizabeth, 551.4 (4-6)
The Ocean World - Kovalik, Vladimir and Nada, 551.4 Kov (4-6)
All About the Sea - Lane, Ferdinand, 551.4 L (4-6)
The Crab That Crawled Out of the Past - Milne, Lorn J., 595 Mil (4-6)
All About Elephants - Burger, Carl, 599.6 Bur (4-6)
Dolphins, The Myth and the Mammal - Alpers, Antone, 599.53 (4-6)
The Dolphin Smile - Devine, Eleanore, 599.6 Der (4-6)
Paws, Hoofs and Flippers - Earle, 599 Earl (4-6)
Fur and Fury - Colby, C. B., 599 Col (4-6)
Gara-Yaka - Varaday, Desmond, 599 Var (4-6)
Rascal - North, Sterling, 599 Nor (4-6)
The Bear Family - Mason, 599 Mas (4-6)
All About Whales - Andres, Roey Chapman, 599 And (4-6)
Valley of the Smallest - Fisher, Arleen, 599 Fis (4-6)
Wild Rodents - Coldy, C. B., 599 Col (4-6)
The First Book of Birds - Williamsen, Margaret, 598.2 Wil (4-6)
Birds Over America - Peterson, 598 Pet (4-6)
Rain in the Woods - Pounds, Glen, 500.9 Rou (4-6)
The Illustrated Library of Natural Sciences - American Museum of Natural History, 502 Ame (4-6)
Fur, Feather, Hair - Lerner, S., 500 Ler (4-6)
Design is a Dandelion - Lovoos, Janice, 500 Lov (4-6)
Prehistoric Mammals - Keen, Martin L., 560 Kee (4-6)
Prehistoric Animals - Scheele, William E., 560 Sch (4-6)
In Woods and Fields - Buck, Margaret, 574 Buc (4-6)

In Yards and Gardens - Buck, Margaret, 514 Buc (4-6)
Evolution - Moore, Ruth, 575 Moo (4-6)
The Wonderful World of Plants and Flowers - Swift, Howard M., 581 S (4-6)
Desert Beauty, The Story of the Cacti - Jeanes, Charlotte, 582 Jea (4-6)
The Wildlife of Australia and New Zealand - Shuttlesworth, Donald E., 591.94 Shu (4-6)
Pagoo - Holling, Hollenf Clang, 595 Hol (4-6)
A Golden Book of Butterflies - Clarke, John Frederick, 595.7 Clu (4-6)
Fishes - Fichter, George S., 597 Fic (4-6)
Traveling With the Birds - Boulton, 598 Bou (4-6)
The Birds - Peterson, 598 Pet (4-6)
Finding Out About Birds - Dilger, William C., 598 Dil (4-6)
The Reptiles - Can, Archie, 598.1 C (4-6)
Men of Mississippi - Holling, Cling, 598.1 Hol (4-6)
Snakes Alive and How They Live - Pope, Clifford, 598.1 Pop (4-6)
See Through the Jungle - Selsam, Millicent, 574 Sel (4-6)
The Tale of a Wood - Kane, 574 Kan (4-6)
Animals and Plants - Fenton, 574 Fen (4-6)
The Tale of a Meadow - Kane, Henry B., 574 Kan (4-6)
Living Things - Jaques, H. E., 574 Jaq (4-6)
Wonders of the Reves - Eifort, 574 (4-6)
Insects - Zim, Herbert, 595.7 Zim (4-6)
Fireflies in Nature and the Laboratory - Poole, Lynn, 595.7 Poo (4-6)
Luna - McClung, Robert M., 595.7 (4-6)
Tiger - McClung, Robert M., 595.7 McC (4-6)

## GEOLOGY

### Geological Forces

Mountains on the Move - Block, Marie Halum, 551.4 (4-6)
Volcanoes New and Old - Colman, 551.554 (4-6)
Rocks and Minerals - Zim, Herbert S., 549 Zim (4-6)
Field Guide to Rocks and Minerals - Pough, Frederick H., 549 Pou (4-6)
Volcanoes and Earthquakes - Adler, Irving, 551.2 (4-6)
Mountains of Fire - Jackson, Vaughan, Genevieve, 551.2 (4-6)
All About Volcanoes and Earthquakes - Pough, Frederick, 551.2 Pou (4-6)
When the Earth Trembles - Fzaieff, Harolin, 551.22 (4-6)
Up From the Sea Came an Island - 551.4 All (4-6)
Search for a Living Fossil - Clymer, Eleanor, 597 Cly (4-6)

### Fossil Records

Underground Riches - Buehr, 622 Bue (4-6)
Deep Treasure - Old, 665.5 Old (4-6)
The First Book of Stones - Cormack, 552 Cor (4-6)
All About Our Changing Rocks - White, Anne Terry, 552 Whi (4-6)
Diamonds - Zim, Herbert, 553 Zim (4-6)
Prehistoric Animals - Dickinson, Alice, 560 Dic (4-6)
Life Long Ago - Fenton, Carroll, 560 Fen (4-6)
From Bones to Bodies - Fox, William, 560 Fox (4-6)
Monsters of the Ancient Seas - Wise, William, 560 W (4-6)
Let's Look at Prehistoric Animals - Warick, Alan R., 560 W (4-6)
Prehistoric America - White, Anne Terry, 560 Whi (4-6)
Fossils, A Guide to Prehistoric Life - Zim, Herbert, 560 Zim (4-6)
Search for a Living Fossil - Clymer, Eleanor, 567 Cly (4-6)
In the Days of the Dinosaurs - Andrew, Roy, 568 And (4-6)
All About Dinosaurs - Andrews, Roy, 568 And (4-6)

Dinosaurs - Bloch, Marie Halun, 568 Blo (4-6)
Dinosaurs - Zim, Herbert S., 568 Zim (4-6)
What is a Dinosaur - Posin, 568 Pos (4-6)
Giant Birds and Monsters of the Air - Wise, William, 568 Wis (4-6)
Dinosaur Hunt - Whitaker, George, 568 Whi (4-6)
Beasts of the Tar Pits - Robinson, W., 569 Rob (4-6)
The First Book of Archaeology - Kubie, 571 Kub (4-6)
The Search for Early Man - Horizon Magazine, 581 Hor (4-6)
The Earliest Americans - Scheele, William E., 571 Sch (4-6)
Stone Age Peoples Today - Baldwin, Gordon, 572 Bal (4-6)
The Story of Man - Jacobson, Daniel, 572 J (4-6)
What's Inside the Earth? - Zim, Herbert, 551 Zim (4-6)
The First Man in the World - White, Anne Terry, 571 Whi (4-6)
The Story of the Ice Age - Wyler, Rose, 551.7 W (4-6)

General Geology

The Earth's Story - Ames, Gerald, 550 (4-6)
The Story of the Earth - Mathews, William H., 551 M (4-6)
The Story of Geology - Syckoff, Jerome, 551 Wye (4-6)
The Picture Book of Salt - Brooks, Anita, 622 Bro (4-6)
About Salt - Telfer, Dorothy, 622.3 Tel (4-6)
The Soils That Support Us - Kellogg, Charles Edwin, 631.4 (4-6)
Why the Mohole - Cromie, William, 551.1 Cro (4-6)
The Earth for Sam - Reed, William, 551 Ree (4-6)
Rocks, Rivers and the Changing Earth - Schneider, Herman Niva, 551 Sch (4-6)
Rivers - Adler, Irving, 551.4 Adl (4-6)
Danger! Icebergs Ahead! - Poole, Lynn, 551.3 Poo (4-6)
The Challenge of the Sea - Clark, Arthur C., 551.4 Cla (4-6)
Waves, Tides and Currents - Clemons, Elizabeth, 551.4 C (4-6)
Coral Reefs - Carling, Lois, 551.4 Dar (4-6)
All About the Desert - Epstein, Sam, 551.4 E (4-6)
Deserts - Goetz, Dalia, 551.4 Goe (4-6)
Grasslands - Goetz, Delia, 551.4 Goe (4-6)
Mountains - Goetz, Delia, 551.4 Goe (4-6)
Islands of the Ocean - Goetz, Delia, 551.4 Goe (4-6)
The Story of Our Earth - Strahler, Arthur N., 551 Str (4-6)

## ASTRONOMY AND METEROLOGY

Solar System

All About the Planets - Lauber, 523.4 Lau (4-6)
Sun and Its Family - Adler, Irving, 523.7 Adl (4-6)
The Sun, Our Nearest Star - Branley, 523.7 Bra (4-6)
The First Book of the Sun - Knight, David C., 523.7 K (4-6)
The Sun - Zim, Herbert S., 523.7 Zim (4-6)
What is a Star - Posin, Daniel A., 523.8 Pos (4-6)
Worlds in the Sky - Fenton, Carroll & Mildred, 520 Fen (4-6)
Wonders of the Heavens - Heuer, Kenneth, 520 Heu (4-6)
The Telescope - Neal, Harry, 522.2 (4-6)
The First Book of Astronomy - Gray, Vivian, 523 Gre (4-6)
You and Space Neighbors - Lewellen, John, 523 Lew (4-6)
Windows to Space - Pickering, James S., 523.1 Pic (4-6)
Life Beyond Our Planet - Posin, Daniel, 523.13 Pos (4-6)
Guide to Outer Space - Branley, Franklyn, 523.4 (4-6)
Planets, Stars, Space - Chamberlain, 523.1 Cha (4-6)
Nine Planets - Nourse, Alan, 523.2 Nou (4-6)

The World Is Round - Ravielli, Anthony, 525 Ray (4-6)
Golden Book of Astronomy - Wyler, 523 Wyl (4-6)
The First Book of Space - Bendick, 629.4 (4-6)
Exploring the Moon - Gallant, 523.3 Gal (4-6)
Exploring Mars - Gallant, Ray A., 523.4 Gal (4-6)
What the Moon Astronauts Will Do All Day - Hill, 629.454 Hil (4-6)
ABC's of Space - Asimov, Isaac, 629.4 Asi (4-6)
What Colonel Glenn Did All Day - Hill, 629.4 Hil (4-6)
1001 Questions Answered About Space - Newton, Clarke, 629.4 New (4-6)
Satellites in Outer Space - Asimov, Isaac, 629.45 Asi (4-6)
Project Apollo - Coombs, Charles, 629.45 Coo (4-6)
The Shape of the Earth - Bendick, Jeanne, 551 Ben (4-6)
You and The Earth Beneath Us - May, 551 May (4-6)
The Story of Our Earth - Strahler, Arthur N., 551 Str (4-6)
The Changing Earth - Viorst, Judith, 550 Vie (4-6)
Shadows - Adler, Irving, 535 (4-6)

Universe

The Nine Planets - Branley, 523.4 Bra (4-6)
Space Nomads - Lopaz, Lincoln, 523.5 (4-6)
Shooting Stars - Zim, Herbert S., 523.5 (4-6)
The Universe - Zim, Herbert S., 523.1 Zim (4-6)
Comets - Zim, Herbert S., 523.6 (4-6)
Point to the Stars - Joseph, Joseph Maron, 523.8 (4-6)
Our Space Age Jets - Colby, Carroll, 629.133 Col (4-6)
Guide to Outer Space - Branley, Franklyn M., 523.4 Bra (4-6)
Look at the Stars - Dr. H. C. King, 523 Kin (4-6)
World in the Sky - Fenton, Carroll, 523 Fen (4-6)
The Sun, The Moon and the Stars - Freeman, Mae & Ira, 523 Fre (4-6)
The Stars for Sam - Reed, William, 523 Ree (4-6)
All About the Stars - White, Anne Terry, 523 Whi (4-6)
Stars - Zim, Herbert S., 523 Zim (4-6)
Fun With Astronomy - Freeman, Mae, 523 Free (4-6)
Planets, Stars and Space - Chamberlain, Joseph, 520 Cha (4-6)
The New Golden Book of Astronomy - Wyler, Rose, 523 Wyl (4-6)
Color - Paschel, 535 Pas (4-6)
The Stars, A New Way to See Them - Ray, H. A., 523.8 (4-6)
The Moon - Brenna, Virgille, 523.3 Bre (4-6)
Exploring the Universe - Gallant, 523.1 Gal (4-6)
The Universe - Bergamini, David, 523.1 B (4-6)
Find the Constellations - Rey, 523.8 Rey (4-6)
Americans in Space - Harper and Row, 629.4 A (4-6)
We Came in Peace: The Story of Man in Space - Smith, Le Roi, 523.3 Smi (4-6)
Illustrated Space Encyclopedia - Bergaust, Erik, 629.4 H (4-6)
All About Satellites and Space Ships, 629.4 Die (4-6)
What's Going on in Space - Hendrickson, Walter B., 629.4 H (4-6)
The Moon: Target for Apollo - Chester, Michael, 629.45 Che (4-6)
You and Space Travel - Lewellen, 629.4 Lew (4-6)
Space Volunteers - Terence, Kay, 629.4 (4-6)
Off Into Space - Hyde, 629.4 Hyd (4-6)
The First Book of Space Travel - Bendick, 629.4 Ben (4-6)

Weather

What is Weather - Syrochi, John, 551.59 Syr (4-6)
Weather in Your Life - Adler, Irving, 551.6 Adl (4-6)
The True Book of Weather Experiments - Podendorf, Illa, 551.6 Pod (4-6)

How Does a Barometer Do? - Courtney, William, 551.6 (4-6)
A Book to Begin on Weather - Waller, Leslie, 551.6 (4-6)
Wonders of the Weather - Antorne, Tex, 551.6 Ant (4-6)
Everyday Weather and How It Works - Schneider, 551.59 Sch (4-6)
Snow - Bell, 551.5 Bel (4-6)
Exploring the Weather - Gallant, 551.59 Gal (4-6)
The Way of the Weather - Spar, 551.59 (4-6)

## MATTER

### Water

Sea Around Us - Carson, 551.4 Car (4-6)
Wonderful World of the Sea - 551.4 Fis (4-6)
What Happens in the Sea - Bethers, Roy, 551.4 (4-6)
The Gulf Stream - Brindze, Ruth, 551.4 Bri (4-6)
Working With Water - Catherall, E. A., 532 C (4-6)

### Air

Giants in the Air - Richards, Norman, 629.13 Ric (4-6)
Air - Adler, Irving, 551.5 Adl (4-6)
What Is Air? - Piltz, Albert, 551.5 Pil (4-6)
Air - Adler, Irving, 551.51 (4-6)
When Air Moves - Freeman, Mae, 533 F (4-6)

### Molecules

The Adventure Book of Chemistry - Goldberg, 540.72 Gol (4-6)
Triumphs of Modern Science - Berger, Melvin, 500 (4-6)
Men and Molecules - Theiler, Carl R., 540 (4-6)
All About the Wonders of Chemistry - Freeman, Ira M., 540 (4-6)
The Peaceful Atom - Kohn, Bernice, 530.76 (4-6)
What is an Atom? - Reuben, Gabriel H., 539 Reu (4-6)
Experiments With Atomics - Beeler, Nelson F., 539.7 (4-6)
You and Atomic Energy and Its Wonderful Uses - 539.7 Lew (4-6)
All About the Atom - Freeman, Ira M., 539 Fre (4-6)
The Story of the Atom - Freeman, Mae, 539 (4-6)

### General

We Came in Peace: The Story of Man in Space - Smith, Le Roi, 523.3 Smi (4-6)
Here's How It Works - Bradley, Duane, 507.2 Bra (4-6)
Energy and Power - Irving, Robert, 531 Irv (4-6)
All About Undersea Exploration - Brindze, 387.5 Bri (4-6)
Basic Laws of Matter - Massey, H.S.W., 530 Bas (4-6)
What is Water? - Hagaman, Adaline P., 551.4 Hag (4-6)

## ENERGY

### Sound

Balloons - Burchard, Peter, 629.13 Bur (4-6)
Junior Science Book of Sound - Anderson, Dorothy, 534 And (4-6)
An Experiment Book - Baer, Marion E., 534 Baer (4-6)
The Story of Sound - Holton, Gerald, 534 Hol (4-6)
Sound and Ultrasonics - Adler, Irving, 534 Adl (4-6)
Magic of Sound - Keltelkamp, 534 Ket (4-6)

Working With Sounds - Catherall, E. A., 534 C (4-6)
The First Book of Sound - Knight, David C., 534 Kni (4-6)
Waves and the Ear - Van Bergeyk, William, 534 Van (4-6)
The First Transatlantic Cable - Nathan, Adele, 621.38 Nat (4-6)
Sounds You Cannot Hear - Windle, Eric, 334 Win (4-6)
Experiments in Sound - Beeler, Nelson, Frederic, 534.072 Bee (4-6)
All About Sound and Ultrasonic - Freeman, 534 Fre (4-6)

Light

The First Book of Color - Paschel, 535 Paw (4-6)
Solar Energy - Hoke, John, 621.47 Hoke (4-6)
Fun With Sun - Halacy, 621.47 Hal (4-6)
Solar Energy - Branley, Franklyn, 621.47 Bra (4-6)
What is Light - Munch, Theodore, 534 (4-6)
Prisms and Lenses - Meyer, Jerome, Sydney, 535 Mey (4-6)
What Makes a Light Go On - Corbett, Scott, 537 Cor (4-6)
The First Book of Color - Paschel, Herbert P., 535 Pas (4-6)
Understanding Light - Tannenbauer, Beulah, 535 Tan (4-6)
Color in Your Life - Adler, Irving, 535.6 Adl (4-6)
Experiments With Light - Beeler, Nelson F., 535 Bee (4-6)
Working With Light - Catherall, E. C., 535 Cat (4-6)
Junior Science Book of Light - Feravalo, Rocco V., 535 Fer (4-6)
Light and Color - Healey, Frederiks, 535 Hea (4-6)

Machines

Big Book of Real Helicopters - Knight, Clayton, 629.13 Kni (4-6)
Complete Book of Jets and Rockets - Ahnstrom, 629.133 Ahn (4-6)
Space Craft and Missles of the World - Baar, James, 629.46 Baa (4-6)
The First Book of Tools - Iberty, Gene, 621.909 Lib (4-6)
A Boy and a Battery - Yales, Raymond, 621.35 Yal (4-6)
Machines - Meyer, 621.9 Mey (4-6)
Engines - Meyer, Jerome, 621.4 Mey (4-6)
Simple Machines and How They Work - Sharp, Elizabeth, 531 Sha (4-6)
What Makes It Go? - Wyler, Rose, 621 Wyl (4-6)
What's Inside of Engines? - Zim, Herbert, 621 Zim (4-6)
How Does It Work? - Koff, Richard Myran, 621 Kof (4-6)
Machines - Adler, Irving, 621 Adl (4-6)
The First Book of Submarines- Icenhower, 623.82 Ice (4-6)
The Story of Submarines - Weller, George, 623.82 Wel (4-6)
The Boy's Book of Model Railroading - Yates, Raymond, 625.1 Ben (4-6)
The First Book of Airplanes - Bendick, Jeanne, 629.1 Ben (4-6)
What Makes a Plane Fly - Corbett, Scott, 629.132 Cor (4-6)
Jets and Rockets and How They Fly - Gottlief, 629.13 Got (4-6)
Helicopters - Lewellen, John, 629.133 Lew (4-6)
First Book of Automobile - Bendick, 629.2 Ben (4-6)
Trucks and Trucking - Beuhr, Walter, 629.2 Beu (4-6)
What Makes a Car Go - Corbett, S., 629.2 Cor (4-6)
Automobiles, How They Work - Yerkow, Charles, 629.2 Yer (4-6)
Everyday Machines and How They Work - Schneider, 643 Sch (4-6)
What Makes the Wheels - Huey, Edward, 530 Hue (4-6)
Simple Machines and How They Work - 531 Sha (4-6)
Civil Airliners Since 1946 - Munson, Kenneth, 629.133 Mun (4-6)
Private Aircraft: Business and General Purpose - Munson, Kenneth, 629.133 Mun (4-6)
This is Automation - Hirsch, S. Carl, 629.8 Hir (4-6)

Automation - Bluemle, Andres, 629.8 Blu (4-6)
The True Book of Automobiles - Carlisle, Norman, 629.4 Car (4-6)
Project Mariner - Stambler, Irwin, 629.43 Stu (4-6)
Magnets and How to Use them - Pine - 538 Pin (4-6)
What is a Magnet - Reuben, Gabriel, 538 Reu (4-6)

Motion

Ride on the Wind - Dalgliesh, Alice, 629.13 Dal (4-6)
History of Flight - Golden Press, 629.13 Gol (4-6)
Complete Book of Jets and Rockets - Ahnstrom, 629.133 Ahn (4-6)
Small Motors You Can Make - Michael, John, 621.31 Mic (4-6)
A Boy and a Motor - Yates, Raymond, 621.313 Yat (4-6)
The Book of Water Power - Gerard, Geoffrey, 621.2 Ger (4-6)
Jets and Rockets and How They Work - Gottlieb, William, 629.42 Got (4-6)
Rockets - May, Julian, 629.4 May (4-6)
The Wind - Bendick, 551.5 Ben (4-6)
The Story of the Trade Wind - Brindze, 551.5 Bri (4-6)
Hurricanes and Twisters - Irving, Robert, 551.5 Irv (4-6)

Gravity

The World of Push and Pull - Ubell, Earl, 531 Ube (4-6)
You and Relativity - Clark, Mary Lou, 530 Cal (4-6)
Faster and Faster - Froman, Robert, 530 Fro (4-6)
Orbit, A Picture Story of Force and Motion - Ruchlis, Hy, 531 Fuc (4-6)

Electricity

Safe and Simple Projects With Electricity - Neal, Charles D., 537.2 Nea (4-6)
The Bright Design - Shippen, Kathern B., 530.09 Shi (4-6)
Television Works Like This - Bendick, Jeanne, 621.388 Ben (4-6)
Discovering Aerospace - Pacilio, James V., 629.1309 Pac (4-6)
Television - Harvey, Tad, 621.388 H (4-6)
Television Story - Floherty, John Joseph, 621.388 Flo (4-6)
Your Telephone and How It Works - Schneider, Herman, 621.386 Sch (4-6)
The Telephone - Brinton, Henry, 621.386 Bri (4-6)
Electronics - Irving, Robert, 621.38 Irv (4-6)
Boys Book of Communication - Yates, 621.38 Yat (4-6)
What Makes TV Work - Corbett, Scott, 621.388 Cor (4-6)
A Book to Begin on Lights - Fargubar, Margaret, 621.32 E (4-6)
Your Telephone: How It Works - Schneider, Herman, 621.3 Sch (4-6)
Let's Go To A Dam - Hamilton, Lee David, 627 Ham (4-6)
Electricity - Waller, Leslie, 537 Wal (4-6)
What is Electricity - Syrocki, B. John, 537 Syr (4-6)
Understanding Electronics - Lewellen, B. John, 537.4 Lew (4-6)
A First Electrical Book for Boys - Morgan, Alfred, 537.2 Mor (4-6)
Electronics From Young People - Bendrick, Jeanne, 537.5 Ben (4-6)
Experiments with Electricity - Beder, 537.2 Bed (4-6)
Junior Science Book of Electricity - Feravolo, Vincent, 537 Fer (4-6)
The First Book of Electricity - Epstein, Sam and Beryl, 537.2 Eps (4-6)

Heat

Solar Energy - Hoke, John, 621.47 Hok (4-6)
Solar Energy - Branley, Franklyn M., 621.47 Bra (4-6)
Fun With Sun - Halacy, 621.47 Hal (4-6)
What is Heat - Munch, Theodore W., 536 Mun (4-6)

The Wonder of Heat Energy - Ruchlis, Hy, 536 Rue (4-6)
Heat - Adler, 536 Adl (4-6)

Nuclear

The Bright Design - Shippen, Kathern B., 530.09 Shi (4-6)
Submarines - Dadin, Micheal, 623.82 Dad (4-6)
The Tenth Wonder, Atomic Energy - Pearl, Carleton, 621.48 Pea (4-6)
Masers and Lasers - Klein, H. Arthur, 621.381 Kle (4-6)
The Story of Atomic Energy - Fermi, Laura, 539.76 Fer (4-6)

General

Atoms, Energy, Machines - McCormick, Jack, 530 (4-6)
The Story of Power - Stodd rd, Edward, 621 Sto (4-6)
The Wonderful World of Energy - Hogben, Lancelot, 621 Hog (4-6)
Telstar - Soloman, Louis, 621.388 Sol (4-6)
Count Down - Colby, C. B., 623.4 Col (4-6)
Flying Kites - Wagenvoord, James, 629.13 W (4-6)
Energy and Power - Irving, Robert, 531 Irv (4-6)
Friction All Around - Pine, Tillie S., 531 Pin (4-6)
Push and Pull - Blackwood, Paul, 531.6 Bla (4-6)
Energy and Power - DeCony L. Sprogue, 531 DeC (4-6)
What is a Rocket - Munch, Theodore W., 621.1 Mun (4-6)
Wonders of Flight - Wells, 629.132 Wel (4-6)
Spacecraft - Haggerty, James J., 629.13 Har (4-6)
Flight Today and Tomorrow - Hyde, 629.13 Hyd (4-6)
Gliders - Kettlekamy, Larry, 629.13 Ket (4-6)
Jets - Verrol, Charles, 629.13 Ver (4-6)
Junior Science Book of Flying - Feravols, Ross, 629.132 Fer (4-6)
Electronics for Young People - Bendick, Jeanne, 629.181 (4-6)
Lift-Off - Coombs, Charles, 629.42 Coo (4-6)
All About Rockets and Space Flight - Goodwin, Harold, 629.4 Goo (4-6)
Magnet - Valens, E. G., 538 Val (4-6)
Working With Magnets - Catherall, E. A., 538 C (4-6)
Junior Science Book of Magnets - Rocco, V. Feravolo, 538 Roc (4-6)
The Boy's Book of Magnetism - Yates, Raymond F., 538 Yat (4-6)
The Story of the Earth's Magnetic Field - Beiser, Germaine, 538.7 Bei (4-6)
Waves: Pathways of Energy - Bixby, William, 630.124 Bix (4-6)
Lightning and Thunder - Irving, James, 551.554 Irv (4-6)
Thunderstorm - Bell, Thelma, 551.554 Bel (4-6)
Here's How It Works - Bradley, Duane, 507.2 Bra (4-6)
All About the Wonders of Chemistry - Freeman, Ira, 540 Fre (4-6)

SCIENCE IN GENERAL

Magic Mixtures: Alloys and Plastics - Carona, Philip E., 660 (4-6)
You and the Oceans - Sherman, Diane, 551.4 She (4-6)
A Book to Begin on Rivers - Sebastian, Lee, 551.4 S (4-6)
Birth of an Island - Selsom, Millicent, 551.4 Sel (4-6)
All About the Jungle - Sperz, Armstrong, 551.4 Spe (4-6)
Waves and Beaches - Bascom, Willard, 551.47 (4-6)
Strange Worlds Under a Microscope - Cosgrove, Margaret, 578 Cos (4-6)
Experiments With a Microscope - Beiler & Bronley F., 578 Bee (4-6)
Wonder World of Microbes - Grant, Madeleene P., 576 G (4-6)
Natural Wonders of the World - Stock, Robert, 574 S (4-6)
Young Scientist Takes A Walk - Bar, George, 574 Bar (4-6)
The True Book of Pebbles and Shells - Podendorf, Illa, 594 Pod (4-6)

Shag - McClung, Robert M., 599 McC (4-6)
Triumphs of Modern Science - Berger, Melvin, 500 Ber (4-6)
You and the Sciences - Broekel, Ray, 500 Bro (4-6)
Science In Your Own Back Yard - Cooper, 500 Coo (4-6)
The Voyage of the Beagle - Darwin, C., 500.9 Dar (4-6)
Secrets of Life - Plall and Disney, 500 Dis (4-6)
Face of North America - Farb, Peter, 500.9 Far (4-6)
Amateur Scientists - Froman, Robert, 500.9 Fro (4-6)
Frontiers of Science - Poole, Lynn, 500 Poo (4-6)
Around the World with Darwin - Selsam, Millicent, 500.9 Sel (4-6)
Through the Magnifying Glass - Schwartz, 500 Sch (4-6)
A Treasury of Science - Shapley, Harlow, 500 Sha (4-6)
1001 Questions Answered About the New Science - Woodburg, David, 500 Woo (4-6)
Your Science Fair Project - Moore, William, 507.2 Moo (4-6)
The Crazy Cantilever and Other Science Experiments - Kadesch, Robert R., 507.2 K (4-6)
Research Adventures for Young Scientists - Bar, George, 507.2 Bar (4-6)
Further Explorations in Science - Milgrom, Harry, 507.2 Mil (4-6)
The First Book of Science - Wyler, 507.2 Syl (4-6)
Exploring the Everyday World - Bartlett, Margaret, 500 B (4-6)
Zoo Expeditions - Bridges, William, 508.3 (4-6)
All About Famous Scientific Expeditions - 508.3 Hol (4-6)
Scientists on Science - Dembling, Merwin, 508 Dem (4-6)
Riches from the Earth - Fenton, 549 Fen (4-6)
Earth's Adventures - Fenton, Carroll L., 550 Fen (4-6)
Land, Sea and Sky - Groh, George, 551 Gro (4-6)
Medicine From Microbes - William, Beryl, 547 Wil (4-6)
Building Blocks of the Universe - Asimov, Isaac, 546 Asi (4-6)
First Chemistry Book for Boys and Girls - Morgan, Alfred, 540.72 Mor (4-6)
Fun With Chemistry - Freeman, 540.72 Fre (4-6)
Edison Experiments You Can Do - Van De Water, 537.072 (4-6)
What is the Biggest? - Fogel, Barbara, 031 Fog (4-6)
Wheels,Wings,and Water - Combs, Charles, 387 Coo (4-6)
The World We Live In - Life Magazine, 574 Lif (4-6)
The Giant Golden Book of Biology - Ames, 574 Ame (4-6)
Under the Microscope - Sloon, Ray, 578 S (4-6)
Young America's Golden Book - Bush-Brown, Louis, 635 B (4-6)
Flowerpot Gardens - Bulla, Clyde Robert, 635.96 B (4-6)
How to Grow House Plants - Selsam, Millicent, 635.9 Sel (4-6)
First Book of Gardening - Kirkus, Virginia, 635 Kir (4-6)
Gifts From the Forest - Wall, 634.9 Wal (4-6)
The Picture Book of Grains - Brooks, Anita, 633.1 (4-6)
The First Book of Fruits - Beck, Barbara L., 634 B (4-6)
Apple Orchard - Eberle, Irmengrade, 634 Ebe (4-6)
About Nuts - Russell, Solveig Paulson, 634 Rus (4-6)
Fruits We Eat - Fenton, Carroll Lane, 634 Fen (4-6)
How to Grow House Plants - Selsam, Millicent, 635.9 Sel (4-6)
About Grasses, Grains and Canes - Uhl, Melvin J., 633 Uhl (4-6)
First Book of Cotton - Rogers, 633 Rog (4-6)
Grasses - Eberle, Irmengarde, 633 Ebe (4-6)
The Land Renewed - Van Dorsal, 631.4 Van (4-6)
Weeds - Hogner, Dorothy Childs, 632 Hog (4-6)
The Man-In-Space - Caidin, Martin, 629.403 R (4-6)
1001 Questions Answered About Space - Newton, Clarke, 629.4 (4-6)
Ceramics: Stone Age to Space Age - Mitchell, Lane, 666.3 (4-6)
The Miracle of Plastics - Cook, James Gordon, 668.4 (4-6)

Let Them Live - Lathrop, Dorothy P., 333.7 Lat (4-6)
New Frontiers in Science - Childrens Press, 500 New (4-6)
One Hundred and One Science Experiments - Podendorf, Illa, 500 Pod (4-6)
Golden Book of Science - Parker, 500 Par (4-6)
Words of Science - Asimov, Isaac, 503 Asi (4-6)
Compton's Illustrated Science Dictionary - 403 Com (4-6)
Discovering Science Through Experiments - Pacilio, James V., 507 Pac (4-6)
Science Activities From A to Z - Challand, Helen J., 507.2 Cha (4-6)
Projects and Experiments in Science - Pacilio, James V., 507.2 Pac (4-6)
Let's Experiment - Keen, Martin L., 507.2 K (4-6)
The Wonderful World - Fisher, James, 525 Fis (4-6)
Fun With Science - Freeman, Mae and Ira, 530.7 Fre (4-6)
Ground Afere - Clifford E., 551.4 Cli (4-6)
Hammond's Nature Atlas of America - Hammond, 574 Jor (4-6)
The Mountains - Life Periodical, 551.43 Lif (4-6)
Wonders of the Living Sea - Carleton, Ray, 551.4 R (4-6)
The Earth for Sam - Reed, 550 Ree (4-6)
Treasures by the Millions - Neal, Harvey, 507.4 Nea (4-6)
The Tools of Science - Adler, Irving, 507.8 Adl (4-6)
Tools of the Scientist - Goldsteen, Rhoda, 507.8 (4-6)
A Sourcebook for Elementary Science - Brandwein, Paul F., 507 Bra (4-6)
Science, Science, Science - Hamilton, 508 Ham (4-6)
Science Through Discovery - Singer, texts grades 4, 5, 6
Science, A Modern Approach - Winston, Text (5)
The Basic Science Program - Scott-Foresman, Text (5)
Science In Your Life - Heath, Text (4)
Probing Into Science - Heath, Text (4)
People and Resources of the Earth - Durell, Text (4)
Today's Basic Science - Harper and Row, Text (4)
Bigger and Better - Winston, Text (4)
The Basic Science Progress - Scott Foresman, Text (6)

## AUDIO-VISUALS

Note: Many of the materials listed can be used at both primary and intermediate grade levels. The figure P (Primary level K-3), I (Intermediate level 4-6) or P&I (both levels) has been placed there as a recommendation that it be used at that particular grade level.

Films:

The River, 917.7 Riv (I)
Sounds Around Us, 534 Sou (I)
Winds Great and Small, 551.5 Wi (I)
The Earth In Motion, 523.1 Ea (I)
The Moon, 523.3 Moon (I)
Be Your Own Weatherman, 551.59 Be (I)
What Makes Weather, 551.59 What (I)
When Air Masses Meet, 551.59 Wh (I)
Work of Rivers, 551.4 (I)
Plant Growth, 581 Pla (I)
Life Cycle of a Mosquito, 595.77 Lif (I)
Simple Machines, 621.8 (P&I)
Hot Water, Friend or Enemy, 628.1 (I)

Filmstrip:

Animals Affect Man and Other Living Things, 301.3 Ani (I)

Our Country Resources and Workers, 331 Our (I)
The Earth, A Great Storehouse, 333 Ear (I)
The Importance of Conservation, 333 Imp (I)
You and Science in Today's World, 507.2 You (I)
Moon Surfaces, 507.2 Moo (I)
Space Race, 507.2 Spac (I)
Weather, 507.2 Wea (I)
From Atom to Universe, 507.2 From (I)
How Scientists Work, 507.2 How (I)
Life Science, 507.2 Life (I)
New Conquests of Nature, 500 New (I)
Building and Orbiting Satellites, 507.2 Bui (I)
The Sky Above Our Earth, 523 Sky (I)
How We Learn About the Sky, 520 How (I)
Nebulae, 523a Sca (I)
Milky Way and Other Galaxies, 523b sca (I)
Mount Wilson and Palomar, 523c Sca (I)
Planets and Comets, 523d Sca (I)
Exploring the Sun, 523e Sca (I)
Exploring the Moon, 523f Sca (I)
Universe in Color, 523g Sca (I)
The Fun's Family, 523.2 Sky (I)
A Multitude of Suns, 523.2 Sky (I)
The Solar System, 523.2 Sol (P&I)
Our Neighbor, The Moon, 523.3 Our (I)
Interesting Things About the Planets, 523.4 Int (I)
Stories of the Constellations, 523.8 Sky (I)
What Are Stars, 523.8 Wha (I)
Looking at the Stars, 823.8a Sky (I)
Winter Has Two Faces, 525a Wint (P&I)
Our Home, The Earth, 525d Our (P&I)
Climate, 525c Cli (I)
Changing Seasons, 525.5 Chang (P&I)
The Sun and Our Seasons, 525.5 Sea (I)
Our Earth in Motion, 525.5 Sea (I)
Dan and Night, 529 Day (I)
Air, 551f Ear (P&I)
Finding Out About Heating Solids, Liquids and Gases, 536 Find (P&I)
Electromagnets, 537 (P&I)
Ice and Glaciers, 551d Ear (I)
The Story of Mountains, 551b (P&I)
Underground Water, 551c Ear (I)
The Story of Rivers, 551a Ear (P&I)
Weather and Climate, 551.5c Wea (I)
What Makes It Rain, 551.58b Wha (I)
Weather, 551.59 Wea (I)
The World of Living Things, 574 Wor (P&I)
How a Plant Grows, 580 HOw (P&I)
Plant: Flowers and Fruits, 580 ab (P&I)
How a Plant Makes Food, 580b How (P&I)
Plant: The Plant Kingdom, 580 aa (I)
Roots of Plants, 580 ac plant (P&I)
Life Cycle of a Plant, 580 ae plant (I)
Stems of Plants, 580 ad plant (P&I)
Behavior of Animals and Plants, 581 Beh (I)
How Animals Live, 590c How (P&I)
Animals Protection (coloring), 591a Ani (I)
Animals and Seasons (land & water migration), 591b Ani (P&I)

Animal Environment (how animals live in the desert), 591c Ani (P&I)
Common Animals of the Woods, 595d Ani (P&I)
Elephants, 595e Ani (P&I)
Squirrels, 595f Ani (P&I)
Animal Environment (how animals live in the artic), 591d Ani (P&I)
Behavior of Animals and Plants, 591.5 Beh (I)
Man Against Insects, 595.7 Man (I)
Insects: Harmful and Useful, 595.7a Ins (I)
Insects: How They Live and Grow, 595.7a Ins (I)
Insects: Their Life Cycles, 595.7b Ins (I)
Insects: What They Are, 595.7c Ins (P&I)
Some Different Kinds of Insects, 595.7d Ins (P&I)
The Insects - Insects That Live in Society, 595.7 ab Ins (I)
What is an Insect, 595.7e Ins (P&I)
How Animals Get Their Food (How Amphibians Get Their Food), 597 How (I)
Amphibians, 598.1a Cla (P&I)
Crocodiles and Lizards, 598.1b Cla (P&I)
Turtles, 598.1c Cla (P&I)
Snakes, 598.1d Cla (P&I)
The Migration of Birds, 598.2a (P&I)
The Story of Steel, 620.1 Ste (I)
People - Our Most Valuable Resource, 614 Peo (I)
Putting Water Power to Work, 621 Put (I)
The Story of Machines, 621.8 Art (I)
Coal, 622.33 Coa (I)
Nothing Can Live Without Water, 628.1 Not (P&I)
Saving the Soil, 631.4 Sav (I)
Oil: From Earth to You, 665.5 Cl (I)
Natural Resources: Coal, Oil, Natural Gas, 665.3 Pet (P&I)
Oil: From Earth to You, 665.5 Oil (I)
Iron and Steel, 669.1 Iro (I)
Platinum Metals, 669.2 Plat (I)
How We Get Our Copper, 669.3 How (I)
How We Get Our Aluminum, 669 How (I)
Solar System, 910 Fun #10 (I)
Violent Forces of Nature - 910 Fun #7 (I)
Famous Americans - The Amazing Benjamin Franklin, 92 (I)
Space Flight, 629.13 Spac (filmstrip set) (I)
    # 1 - Physical Problems
    # 2 - Flying With Jets and Rockets
    # 3 - Human Problems
    # 4 - Overcoming Gravity
Walt Disney's Space and the Atom, FS 629.4s (filmstrip set) (P&I)
    # 1 - Man Learn to Fly
    # 2 - Man and the Moon
    # 3 - Flight into Space
    # 4 - Man in Space
    # 5 - Man in Flight
    # 6 - Flight Around the Moon
    # 7 - Flight to Mars
    # 8 - Man Discovers the Atom
    # 9 - Our Friend the Atom
    #10 - Man Becomes an Astronomer
Earth Science, 333.9 (filmstrip set) (I)
    Water Conservation, 333.9
    Dating Geologic Events, 550
    Life and Death of Freshwater Lakes, 551.4

Plants Around Us, 580 (filmstrip set) (P&I)
# 1 - Different Kinds of Plants
# 2 - Where Plants Grow
# 3 - Many Plants Are Green
# 4 - Somethings Green Plants Need
# 5 - Parts of a Flower Plant
# 6 - What Are Flowers
# 7 - What Are Fruits
# 8 - How a Bean Seed Grows
# 9 - How Seed Plants Start Growing
#10 - How to Know Trees
#11 - How We Use Plants
#12 - Food From Plants

Exploring With Science, 500 Exp (filmstrip set - shortstrip) (P&I)
# 1 - Old Mother Sun
# 2 - Our Planet Earth
# 3 - You and the Universe
# 4 - Season Come and Go
# 5 - What Day Is It
# 6 - When Night Comes
# 7 - What is Weather
# 8 - Power Moves Things
# 9 - Meet the Plant Family
#10 - Meet the Animal Family
#11 - Meet the Human Family
#12 - You Are Alive

Why of Elementary Science, 621 (filmstrip set) (P&I)
Simple Machines
# 1 - How Wheels Help Us
# 2 - How Levers Help Us
# 3 - How Ramps & Screws Help Us
# 4 - How Wedges Help Us

Physical/Chemical Changes in Everyday Living, 500 Phys (filmstrip set) (I)
# 1 - Things in the World Change
# 2 - Changes All Around Us
# 3 - Your Changing World

Physical Science, 520 (filmstrip set) (P&I)
Oceans, 551.4
Rocks and Minerals, 543
Moon, Sun and Stars, 520
Deserts, 551.4
Seasons, 525
Air Around Us, 533

Biological Science, 598.1 (filmstrip set) (P&I)
Dinosaurs, 568
Pets, 636
Farm Animals, 636
Reptiles, 598.1
Tropical Fishes, 597
Your Body and You, 612

Natural Science, 500's (filmstrip set) (P&I)
Trees, 582
Birds We Know, 598
Insects, 595.7
Animals of Sea and Shore, 590
Animal Babies, 590
Plants We Know, 580

Different Kinds of Animals, FS 590 (filmstrip set) (P&I)
- Some Water Animals, Amphibians
- Mammals, Reptiles
- Birds, Insects

Earth, 550 (filmstrip set) (P&I)
- A Story of Our Earth: Rocks and Soil, 550
- The Ice Age, 551.7
- Coal-A Fossil Fuel, 549
- How Crystals Are Formed, 548
- The Story of Mountains, 550

Birds and Their Songs, 598 Bir (filmstrip and records) (P&I)
- Part 1
- Part 2
- Part 3
- Part 4

Plants and Their Environment, 580 (filmstrip set and records) (P&I)
- # 1 - Flowers Transfer Pollen
- # 2 - How Plants Use Leaves
- # 3 - How Seeds and Fruits Travel
- # 4 - How Plants Use Other Plants

Filmloops:

Bighorn Sheep, 591 Big (P&I)
Fawn Deceives Mountain Lion, 591 Faw (P&I)
Coyote, 591 Coy (P&I)
How Spiders Capture Prey Spiders with Webs, 595.4 How (P&I)
How Spiders Capture Prey Spiders Without Webs, 595.4 Spi (P&I)
Seed Dispersal, 581 See (P&I)
Self-Planting Seeds, 581 Sel (P&I)
Cheetah Hunting Food, 590 Chee (P&I)
Scavengers of Africa, 590 Sca (P&I)
Water Animals Hunting Food, 590 Wat (P&I)
Salmon Run, 567 Sal (P&I)
What is a Mammal, 599 Wha (P&I)
Marine Predators - Competition for Food, 591.92 Mar (I)
Animal Camouflage, 595.7 (I)
Cecropia Moth, 595.7 (I)
Budding of Yeast Cells, 576 (I)
What is a Flower, 582 Wha (I)
What is a Tree, 582.16 Wha (I)
Plankton Eaters, 590 Pla (I)
Faults, 551 Fau (I)
Grand Canyon River, 551 Gra (I)
Sedimentation, 551 Sed (I)
Geysers and Hot Springs, 551.2 Gey (I)
A Volcano In Action, 551.2 Vol (I)
Glaciers, Frozen Streams, 551.3 Gal (I)
Strange Rock and Land Formations, 551.3 Str (I)
Water and Its Many Faces, 551.4 Wat (I)
The Gerbil, 599 Ger (P&I)
Brown Bear Diet, 599 Bea (P&I)
Common American Birds (habits), 598.2 Com (P&I)
Common American Birds (nests and young), 598.2 Bir (P&I)
Rattlesnake, 598.1 Rat (P&I)
Birds Building Nests, 598 Bir (P&I)
Shark Feeding Frenzy, 597 Sha (I)
Sheep Ranching, 630.1 She (P&I)

Logging, 634.9 Log (P&I)
Eskimo Seal Hunt, 919.8 Esk (P&I)
Surviving In Anartica, 919.9 Sur (I)
The Hittite Sun, Parts I & II, 930 Hit (I)

Slides:

Snake (copperhead), 568 Sna (P&I)
Amoeba, 593 Amo (I)
Crayfish, 595 Cra (P&I)
Frogs, 597 Fro (P&I)
Lizards, 598.1 Liz (P&I)
The Eye, 611 Eye (P&I)
Human Blood Cells, 612 Blo (I)
Lung, 612 Lun (I)
Stomach, 612 Sto (I)
Denver Zoo and Gardens (10 slides) (P&I)
Rocks, 552 Roc (P&I)

Microslides:

From Egg to Chick, 636.5 Fro
From Flower to Fruit, 634 Fro (I)
Life in a Pond, 574.92 Lif (I)
The Reflex Arc (spinal cord - motor neuron), 612 Ref, (I)
Parts of an Insect, 595.7 Par (I)
Harmful Bacteria, 589.9 (I)
Helpful Bacteria, 589.9 Bac (I)
Plants That Are Not Green, 580 Pla (I)
Cells of Plants and Animals, 576 Cell (I)

Transparencies:

Comets, 523 Com trans (I)
Meteors and Meteorites, 523 Met trans (I)
The Milky Way, 523 Mil trans (I)
The Universe: Solar System, 523.2 Sol trans (P&I)
Moons, 523.3 Moo trans (I)
The Sun's Family, 523.4 Suns trans (I)
A Look Inside the Earth, 525 Alo trans (I)
Clouds From Gemini, 551.5 Wea trans (I)
Numbus Photo of U.S.A.
Hurricane and Storm Clouds
Cloud Formations, 551.5 tr 23 (I)
Weather, 551.5 Wea trans (I)
Weather: The Warm Front, 551.5 trans (I)
Animal Cells and Plant Cells, 574.8 Ani trans (I)
Green Plants - Food Factories and Storehouses, 580 Gree trans (I)
Plants: Parts of a Plant, 580 Pla trans (P&I)
Plants: Parts of a Flower, 581 Flo trans (P&I)
Housefly - Life Cycle, 595.7 Hou Trans (P&I)
Insects: Characteristics, 595.7 Ins trans (P&I)
LifeCycle: The Beehive, 595.7 Bee trans (P&I)
Housefly: Characteristics, 595.7 Hou trans (P&I)
Life Cycle of the Butterfly, 595.7 But trans (P&I)
Mammal Characteristics, 596 Mam trans (P&I)
Mosquito - Life history, 595.7 life trans (P&I)
Mosquito, 595.7 Mos trans (P&I)

Mosquito - Life Cycle, 595.7 Mos trans (P&I)
Life Cycle: The Ant Colony, 596 Ant Trans (P&I)
Intelligence of Animals, 596 Int trans (P&I)
Life Span of Animals, 596 Lif trans (P&I)
Vertebrates - Characteristics, 596 Vert trans (P&I)
Amphibians - Characteristics, 597 Amph trans (P&I)
Fishes and Amphibians, 597 Fis trans (P&I)
Fishes - Characteristics, 597 Fis trans (P&I)
Frog - Life Cycle, 597 Frog trans (P&I)
Birds and Reptiles, 598 Bir trans (P&I)
Birds - Characteristics, 598 Bir trans (P&I)
Animals Without Backbones, 598.1 Ani trans (P&I)
Reptiles - Characteristics - 598.1 Rep trans (P&I)
Mammals - Characteristics, 599 Mam trans (P&I)
The Story of the Air You Breathe, 612 Stor trans (I)
Internal Combustion Engine, 621 Int trans (I)
Flight: Rocket Engines, 621 Fli trans (I)
Flight: The Turbojet Engine, 621 Fli trans (I)
How the Earth is Divided, 912 How trans (I)
Flight: Force of Flight, 629.13 Fli trans (I)
Parts of an Airplane, 629.13 Par trans (I)
Transmobile - First Class Lever, 621 Fir trans (P&I)

Charts and Pictures:

Birds (P&I)
Transportation (P&I)
Luminus Star, 523.8 Lum (I)
Solar System, 523.2 Sol (I)
Nature and Science - Our Ocean of Air, 533 (I)
Nature and Science - The Ages of Earth, 550 (I)
Understanding Our Weather, 551.59 Und (P&I)
Pondlife, 574 (I)
Nature and Science - Round Trip to the Moon, 629.128 (I)
The Exploration of Space, 629.13 (I)
Nature and Science - Evolution, 575 (I)
Nature and Science - The Larger Orders of Insects, 595.7 (I)
Nature and Science - How Pollen Gets Around, 580 (I)
Life in the Sea, 591.92 Lif (P&I)
Animals Without Backbones, 592 (P&I)
Wild Animals, 591.5 (P&I)
Reptiles and Amphibians, 598.1 (P&I)
Moths and Butterflies, 595.78 (P&I)
Common Insects, Group 1, 595.7 (P&I)
Common Birds, Group 1, 598.2 (P&I)
Physiology (x-rays), 612 (I)
Work and Machines, 621 (P&I)
Simple Machines, 621.9 Sim (P&I)
The Eye, 612 Eye (P&I)
Solar System, 523.2 Sola (I)
Weather Charts, 551.5 Wea (P&I)
Biology (Parts of a plant, insect, bird), 570 (P&I)
Earth, 525 (P&I)
Oceanology, 551.4 (P&I)
Matter and Energy, 531 (P&I)
Electricity and Magnetism, 537.2 (P&I)
Heat, Light, and Sound, 531 (P&I)
Gravity and Other Forces, 521 (P&I)

Nature and Science - How Seeds Get Around, 580 (P&I)
Plants, 580 (P&I)
Deer, 599.5 (P&I)
Frog-1, 570 Mar (P&I)
Fish-2, 570 Mar (P&I)
Turtle-3, 570 Mar (P&I)

Records:

Wait Till the Moon is Full, 398.2 S214 (I)
A Day in the Life of a Dinosaur, SC A Day (I)
A Signpost to Conservation - Wildlife & Ecology, 333 (I)
Space Songs, 530.1 Gla (P&I)
Weather Songs, 551.59 Gla (P&I)
Nature Songs, 574 (P&I)
The Birds World of Song, 590 S219 (I)
Electronic Music, 780 Elect (I)
Poetry - The First Snowball - To a Waterfowl, 810 Poe (P&I)
Singing Science Sampler from Ballads for the Age of Science: Insects, Conservation, Gravity, etc., 500 (P&I)
Tom Glazer, Weather Songs, Packet C., 551.59 (P&I)

Tapes:

Magic Road of Sounds, 411 Mag (P&I)
Stories in Season - Spring & Summer, Sc Stor (P&I)
Stories in Season - Fall & Winter, Sc Stor (P&I)
Eli Whitney and Thomas A. Edison, 920 HG 63 (I)
Dr. Jonas Edward Salk & Albert Einstein, 920 HG 62 (I)
Mdm. Marie Curie & Dr. Albert Schweitzer, 920 HG 61 (I)
John James Audubon & George Washington Carver, 92 HG (I)
Noise and Musical Notes, 780 Noi (P&I)

Kits:

Science Treasure Chest, Sets #1 & #2, 500 Sci (P&I)
Boxed Set Shells, 594 Shel (P&I)
Seeds (flannel board aids), 581 See (P&I)
Heat Engines: The Gasolin and Diesel Engines, 621.4 Heat (I)
Fundamentals of Jet Propulsion, 629.13 Fund (I)
Atomic Energe, 500 Ato (I)
Fundamentals of Light, 535 Lig (I)
Fundamentals of Sound, 534 Fund (P&I)
Bell System Science Experiment #4, 535 Ex (I)
Plant Growth, 580 Pla (P&I)
Plants and Foods (Instructo flannel board), 580 Pla (P&I)
Montana Geology, 978.6 Mont (I)
Air Age Education Materials for Elementary Teachers (AF), 629.14 Air, 6 kits, (I)

Models:

Radiometer - A Solar Engine, 523.7 Rad (P&I)
Chick-Chick Egg Incubator, 598 Chi (P&I)
Solar Mobile, 523.7 Sol (I)
Junior Turn-A-Gear, 621 boxed set (P&I)
Lever, 621.9 Lev (P&I)
Screw, 621.9 Scr (P&I)

Solar System, 523.2 Solar (P&I)
Universal Planetarium, 523.2 Solar (P&I)
Gear, 621.9 Gea (P&I)
Fulcrum Balance, 621.9 Ful (P&I)
Wheel and Axle, 621.9 Whe (P&I)
Inclined Plane, 621.9 Inc (P&I)
A Gear Train, 621.9 Gear (P&I)

Equipment:

Giant Magnifier, 500 Equip (P&I)
Miscellaneous Microscopes
Weather Vanes
Weather Check, Calibrated Official Set #1 & Set #2, 551.5 (I)

Specimen:

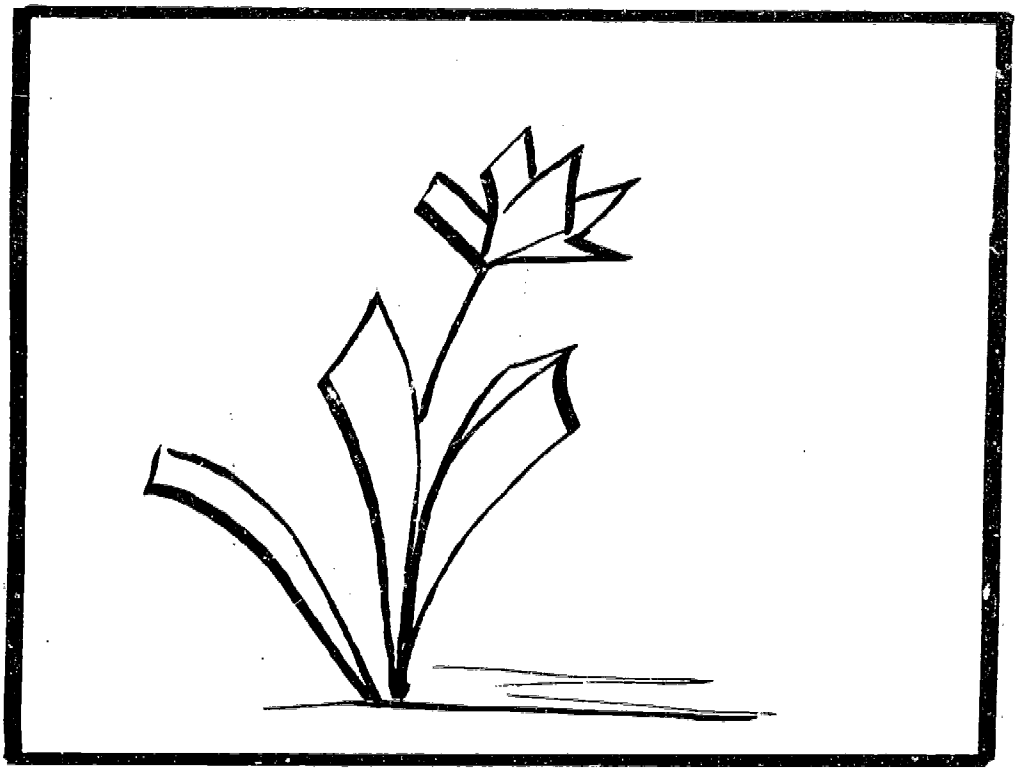
Specimen Fascinating Mineral, 552 Rec (P&I)
Specimens of Frog, clam, fish, starfish (P&I)

Games:

Curtis Martin - The Story of Shells, 594 Game She (P&I)
The Earth and Its Moon (flannel board aid), 523.1 game (P&I)
Science Quizzer, 500 Sci (P&I)

Vertical File: (Alphabetically arranged pamphlets, booklets, etc.).

Aluminum
Atomic Energy
Birds
The Body
Butterflies
Coal
Conservation
Copper
Dinosaurs
Ecology
Fossils
Frogs
Inventions
Machines, Tools
Moon
Nature Study
Oceans
Oil Industry
Power
Reptiles
Rocks
Science Experiments
Science Measruements
Space
Trees
Turtles
Weather
Water
World Around You



# LIFE SCIENCE

LIFE SCIENCE

The student will be given the opportunity to appreciate and understand that man is part of a complex of balanced interactions called the biosphere.

I. Develop an understanding of life in the biosphere.

Objective: The student will begin to discover, through observation and investigation, that the biosphere includes both interactions among organisms, and interactions between organisms and the non-living environment.

A. Laboratory Technique

1. The student will be able to begin to develop good laboratory technique.
2. The student will be able to operate the mocroscope properly.
3. The student will be able to apply the given laboratory safety procedures.
4. The student will be able to begin to record laboratory work using the scientific method.

B. Extent of the Biosphere

1. The student will be able to acquaint himself with the variety and distribution of life on the earth.

C. Interactions in Grass/Water Mixture

1. The student will be able to discover the interaction between the organisms and their non-living environment.

II. Develop an understanding of investigating an interaction - Photosynthesis

Objective: The student will be given the opportunity to discover the most basic interaction that exists on earth between green plants and their environment.

A. Light and Green Plants

1. The student will be able to observe and explain the importance of light in food production by plants.
2. The student will be able to apply food tests for detecting photosynthetic activity.
3. The student will be able to explain that solar energy is converted to chemical energy.

B. $CO_2$ and Green Plants

1. The student will be able to observe and explain the importance of $CO_2$ in food production by plants.
2. The student will be able to explain the relationship between an hypothesis and a theory.
3. The student will be able to explain the use of a control in experimental work.

C. Location of Food in a Green Plant

1. The student will be able to observe and axplain the importance of chlorophyll in food production by plants.

D. Gas Production by a Green Plant

1. The student will be able to observe and explain that oxygen is produced during photosynthesis.

E. The Final Ingredient - Water

1. The student will be able to observe and explain the importance of $H_2O$ in food production by plants.

F. Comparing Cells

1. The student will be able to explain what the cell theory is and its origin.
2. The student will be able to relate the size and structure of different cells with their functions.

III. Develop an understanding of an interaction within an organism - Digestion

Objective: The student will be given the opportunity to investigate in detail an interaction within an organism - digestion of food.

A. Anatomy of a Digestive System

1. The student will be able to describe the parts of the digestive system in an animal.
2. The student will be able to conduct a good laboratory dissection.

B. Food Location in Plants Seeds

1. The student will be able to discover, through observation and investigation, the location of foods in a plant seed.
2. The student will be able to infer that there is a relationship between embryo growth and cotyledon shrinkage.
3. The student will be able to identify the two foods in the seed through food testing techniques.

C. A Cell Model - Diffusion Through a Semi-Permeable Membrane

1. The student will be able to ascertain that some foods will pass through a semi-permeable membrane while others will not.
2. The student will be able to explain the above phenomenon using food molecule size.

D. A Problem - Starch Breakdown to Simple Sugars

1. The student will be able to observe, through investigation, the breakdown of starch to simple sugars.

E. Soaked Beans and Starch

1. The student will be able to deduce through investigation, that a biological converter caused the breakdown of starch into sugar in the seed plant.

2. The student will be able to compile all the previous material on the plant seed and conclude that digestion of starch into sugar had to take place in order for the embryo to grow.
3. The student will be able to conclude that plants digest food just as animals digest food.

F. Starch and Saliva

1. The student will be able to conclude through investigation that a biological converter is present in saliva and it causes the breakdown of starch.
2. The student will be able to explain what an enzyme is and what it does.

G. Factors Influencing Digestion

1. The student will be able to explain that certain conditions must exist in order for digestion to occur (e.g., termperature, pH, etc.).

H. Diffusion and the Living Cell

1. The student will be able to explain the process of diffusion and how it relates to the living cell and food absorption.

I. The Human Digestive System

1. The student will be able to explain the digestive system of a human.
2. The student will be able to relate which foods are digested by their corresponding enzymes.
3. The student will be able to explain where the various foods are digested in the human digestive system.
4. The student will be able to contrast the structure of the three main groups of foods.

IV. Develop an understanding of transport problems - The Circulatory and Vascular Systems

Objective: The student will be given the opportunity to investigate, observe and explain the transport systems in both plants and animals.

A. The Circulatory System of a Frog

1. The student will be able to contrast the circulatory system of a frog with the circulatory system of other animals.

B. Why Have a Circulatory System?

1. The student will be able to discuss the reason a circulatory system is needed in animals (e.g., gas exchange and food transport in cells).

C. The Vascular System in a Plant

1. The student will be able to explain, through observation and investigation, the need for a vascular system in a plant.
2. The student will be able to describe the structure of some of the various parts of a plant (e.g., roots, stems and leaves).

V. Develop an understanding of how food is used - Respiration

Objective: The student will be given the opportunity to explore, investigate, observe and explain the use of foods in cell respiration.

A. Energy in Food

1. The student will be able to explain that all foods contain energy in the form of chemical energy.
2. The student will be able to determine the amount of energy in food (e.g., calories).
3. The student will be able to relate potential energy and kinetic energy.

B. The Big Picture

1. The student will be able to explain how photosynthesis, digestion, transportation and respiration are interrelated among plants and animals and within themselves.

VI. Develop an understanding of internal balance.

Objective: The student will be given the opportunity to investigate and explain the organisms ability to maintain a constant cellular environment in an ever-changing exterior environment.

A. Nervous System

1. The student will be able to relate through investigation the role that the nervous system plays in the internal balance.
2. The student will be able to discribe the structure of the nervous system in the animal.
3. The student will be able to differentiate between automatic and conscious controlled nervous reactions.
4. The student will be able to ascertain that other internal balance systems operate using nerve impulses.

B. Excretion

1. The student will be able to explain the importance and operation of the excretory system in the animal.

C. Endocrine System

1. The student will be able to explain the functioning of the glands in the endocrine system.
2. The student will be able to explain the function of the endocrine system.

D. Plant Growth Regulator

1. The student will be able to conclude that auxins regulate plant growth, according to the external environment in the plant.

VII. Develop an understanding of Man and Nature.

Objective: The student will be given the opportunity to discuss, observe, and investigate the pollution problems that face man today and in the future.

A. What is Pollution?

1. The student will be able to identify what pollution is and where it originates.

B. Over-Population

1. The student will be able to discuss the problem of over-population and its possible consequences.

C. Benefit or Harm

1. The student will be able to conclude that there are two sides to the pollution problem and that the good must be weighted against the bad in order to make the right decisions.

VIII. Develop an appreciation for and an understanding of ecological interactions.

Objective: The student will be given the opportunity to discuss, investigate and observe some of the complexities of the interactions among living things.

A. Sampling a Population

1. The student will be able to apply some of the methods used in sampling the size of a population.

B. Changing Populations

1. The student will be able to explain that populations are constantly changing and are dependent upon any environmental changes (e.g., biotic potential, carrying capacity, and environmental resistance).

C. Population Cooperations and Competition

1. The student will be able to explain that there exist cooperative and competitive interactions between populations and individuals within the population.

D. Food Chains and Food Webs

1. The student will be able to explain the concepts of food chains and food webs.

E. Ecosystems

1. The student will be able to combine the previous concepts of population interactions in order to explain the many different ecosystems present (e.g., grassland, desert, conifer forest, etc.).

F. Population Dispersal

1. The student will be able to explain that plants and animals move from one location to another by various mechanisms in order to disperse.

G. Succession

1. The student will be able to explain what succession is and how it relates to changes in ecosystems.

IX. Develop an understanding of organisms in the biosphere.

Objective: The student will be given the opportunity to observe and discuss how organisms in the biosphere are grouped according to taxonomic nomenclature.

A. Naming an Organism

1. The student will be able to explain how organisms are named.
2. The student will be able to explain what a classification system is.

B. Use of a Simple Key

1. The student will be able to construct and use a simple key.

X. Develop an understanding of reproduction.

Objective: The student will be given the opportunity to relate that reproduction in its broadest sense is the maintenance of the species.

A. The New Organism Grows

1. The student will be able to describe and explain the process of asexual reproduction.
2. The student will be able to describe and explain the process of sexual reproduction.
3. The student will be able to explain how sexual and asexual reproduction are related to the survival of the species.

XI. Develop an understanding of genetics.

Objective: The student will be given the opportunity to explain how characteristics are inherited and how variations occur.

A. Inheritance

1. The student will be able to explain that the genetic make-up of an offspring is determined by its parents.
2. The student will be able to predict the genetic make-up of an individual given the parental genetic make-up.
3. The student will be able to explain how the sex of an individual is determined.

XII. Develop a knowledge that change occurs through time.

Objective: The student will be given the opportunity to explain that evolution, through the environment, can cause the perpetuation or elimination of variations among individuals of a species.

A. The Future

1. The student will be able to infer that man is changing his environment so fast that other organisms, including himself, will not be able to adapt in the future.
2. The student will be able to infer that whole ecosystems could completely disappear.

RESOURCES:

Books:

Nature's Ways - Andrews, Roy Chapman; Crown Publishers, New York, 1951
The World We Live In - Barnett, Lincoln; Simon and Schuster, New York, 1955
Luther Burbank, Plant Magician - Beatty, John Yocum; Julian Messner, New York, 1943, 92 Bur
Useful Plant and Animals - Blough, Glenn O.; Row, Peterson & Co., Evanston, Illinois, 1948
Your Forests - Bruere, Martha S.; J. B. Lippincott Co., Philadelphia, 1945
Animals Without Backbones - Buchsbaum, Ralph; University of Chicago Press, Chicago, 1948, 592 Bu
Water Or Your Life - Carhart, Authur; J. B. Lippincott Co., Philadelphia, 1951
Insects in Your Life - Curran, Charles Howard; Sheridan House, New York, 1951
Insect Adventures - Fabre, Jean Henri; Dodd, Mead & Co., New York, 1950
Living Things - Fitzpatrick, F. L. and Bain, T. D.; Holt, Rinehart & Winston, New York, 1958
Watch Your Step - Floherty, John Joseph; J. B. Lippincott Co., Philadelphia, Penn., 1950
Milestones of Medicine - Fox, Roth; Random House, New York, 1950
The Insect World - Harpster, Hilda T.; Viking Press, New York, 1947
Medical Milestones - Marriott, Henry Joseph; Williams & Wilkins Co., Baltimore, Maryland, 1952
Facts About Alcohol - McCarthy, Raymond; Science Research Assoc., Chicago, 1951
If You Want to do a Science Project - National Science Teachers Assoc., 1954
Modern Health - Otto, James H., Julian, Clouyd J., and Tether, Dr. Edward; Holt, Rinehart & Winston, New York, 1959
Animals We Know - Parker, Bertha M.; Peterson & Co., Evanston, Ill., 1950
Foods - Parker, Mertha M.; Row, Peterson & Co., Evanston Ill., 1948
Seeds & Seed Travels - Parker, Mertha M.; Row, Peterson & Co., Evanston, Ill., 1950
Soil - Parker, Bertha M.; Row, Peterson & Co., Evanston, Ill., 1949
Water for the People - Riedman, Sarah H.; Henry Schuman, Inc., New York, 1952
How Your Body Works - Schneider, Herman and Nina; Scott, Foresman & Co., New York, 1950
Plants in the City - Schneider, Herman and Nina; John Daey Co., New York, 1951
Men, Microscopes and Living Things - Shippen, K. B.; Viking Press, New York, 1955
Miracle Drugs - Sikoloff, Boris; Prentice Hall, New York, 1949
Land Renewed - Van Desal W.; Oxford Book Co., New York, 1946
Walter Reed, Doctor in Uniform - Wood, Laura Newbold; Julian Meslner, New York, 92 Ree
Here's Your Hobby - Zarchy, Harry; Alfred A. Knopf, New York, 1950, 738.3 Zar
Plants - Zim, Herbert and Cooper, Elizabeth K.; Harcourt, Brace & Co., New York, 1947
The Fossil Book - Fenton, Carroll, 560 Fen
Origin of Species - Darwin, Charles, 575.01 Da
Silent Spring - Carson, Rachael
Voyage of the Beagle - Darwin, Charles, 574.0 Dar
Horses - Simpon, George G., 599.725 Sim
Life - Simpon, George G., 574 Sim
Edge of the Sea - Carson, Rachael, 574.92 Car
Silent World - Cousteau, Jacques, 574.92 Cou
The Living Sea - Cousteau, Jacques, 574.92 Cou
Living Cell - Scientific American, Sept., 1961
The Cell - Pfeiffer, John, 574 Pfe

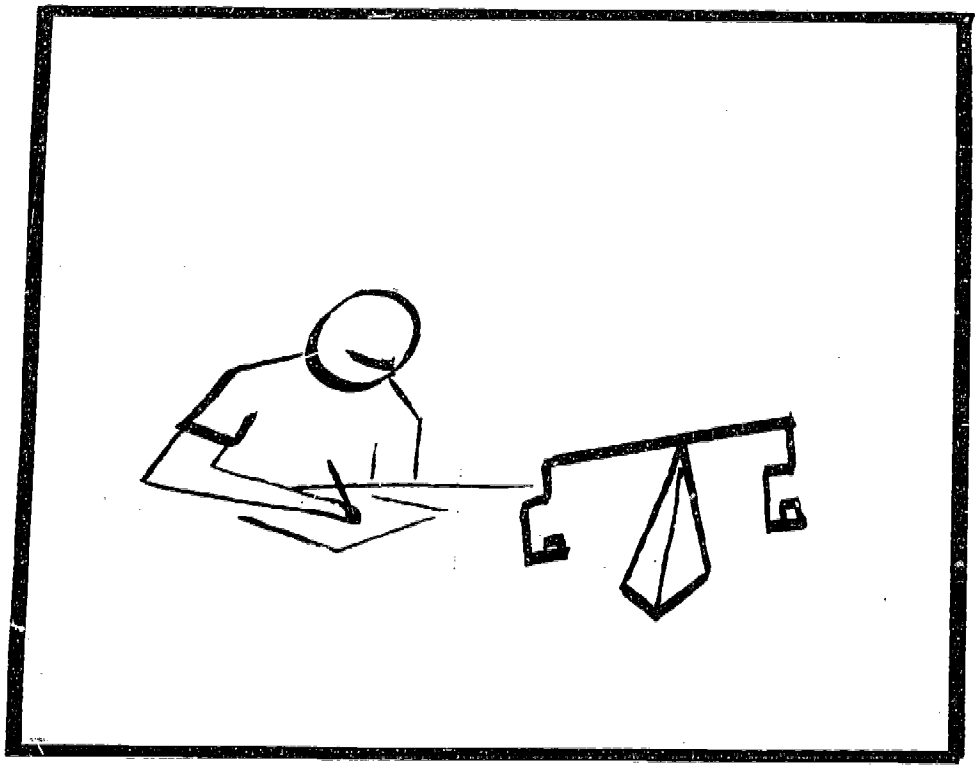
The Role of Light in Photosynthesis - Scientific American, June, 1960
The Insects - Peter Farb, 595.7 F
The Birds - Peterson, R. T., 598 Fet
The Fishes - Ommanney, F. P., 597 Lif
Pocket Guide to Birds - Cruichshank, Alan, 598 Cur
How to Know the Birds - Peterson, R. T., 598 Pet
The Adventure Book of Birds - Jerr, William, 598 Jer
Fishes - Zim, Herbert S., 597 Zim
The Insect World - Lobsenz, Norman, 595.7 Lob
Animal Behavior - Tinbergen, Niko, 591 Lif
Reptiles - Carr, Archie, 591.1 Car
Primates - Eimerl, S. & De Vore, 599 Lif
Living Mammals of the World - Sanderson, I. T., 599 Sa
The Forest - Farb, Peter, 571, Far
Trees - Coe, ..., 582 Coe
Ecology - Farb, Peter, 571 Far
Fundamentals of Ecology - Odum, E. P., 571 Odu
Forest and the Woodland - Collins, Stephen, 575 IV
Fresh & Salt Water - Catbury, B. B.; 575 II
Evolution - Moore, Ruth, 575 M
Desert - Klots, A. B. & E. G., 575 V
Field and Meadow - Ress, E. S., 575 I
The Plants - Went, F. N., 580 Lif

Films and Filmstrips:

Mitosis, 574.8
Mimicry, 574
Leaves of Plants, 580 AF
Photosynthesis, 581 A
Kinds of Cells, 581 B
Your Bloodstream, 612
Food in the Human Body, 613.2
Plant Mitosis, Grade School
Behavior of Animals & Plants, 581, Grade School
Plants & Their Environment, 580, Grade School
How Plants Live & Grow, 581, Grade School
Walt Disney Series, 599, Grade School

Movies:

Photosynthesis, 581 D
Life in the Desert, 590 B
Heart & Circulation, 612.1
Digestion of Foods, 612.3
Life Cycle of a Mosquito, 595.77, Grade School



# PHYSICAL SCIENCE

GRADE EIGHT

PHYSICAL SCIENCE (IPS)

Objective: The student should be given the opportunity to study matter by developing and using the scientific method eventually leading to a development of an atomic model of matter.

I. Develop proper laboratory techniques.

A. The student will be able to identify and safely use the lab equipment issued him.

B. The student will be able to write a lab report in correct form established by the instructor.

II. Measure and learn about those characteristic properties of matter which will enable him to identify two given objects as to being the same or different.

A. Investigate and measure the "volume" property of matter:

1. The student will be able to obtain through measurement and computation the volume of regular-shaped objects (e.g., rectangular solids).
2. The student will be able to obtain through water displacement volumes of irregular solids (e.g., sand).
3. The student will be able to conclude through experiment and demonstration that volume of matter varies with temperature changes, pressure changes and when mixed to form solutions.

B. Investigate and measure the "mass"property of matter:

1. The student will be able to use the equal arm balance and establish its precision.
2. The student will be able to construct graphs.
3. The student will be able to conclude that mass of matter does not change (i.e., law of conservation of matter).

C. The student will compute the density of a substance (solid, liquid or gas) and realize that density is a characteristic property of a material independent of its size, mass, or shape of that object (e.g., aluminum has a unique density 2.7 glcm3 regardless of its being a piece of foil or a solid block as big as a house).

D. Investigate and measure the thermal expansion of substances:

1. The student will be able to conclude through experimentation and demonstration making use of an amplifier that thermal expansion for liquids and solids is a characteristic property of that substance.
2. The student will be able to conclude through demonstration that thermal expansion for any gas is the same and therefore not a characteristic property.

E. The student will determine through temperature vs time graphs that some substances have a characteristic freezing and melting point.

F. The student will determine through temperature vs time graphs the boiling point of some common substances and establish that boiling point is a characteristic property of a substance.

G. The student will investigate solubility as a characteristic property of substances:

1. The student will be able to establish effect of temperature on solubility.
2. The student will be able to experiment with different solvents (e.g., alcohol, acid).

III. Separate mixtures of substances by utilizing differences in characteristic properties, and establish the distinction between mixtures and pure substances.

A. The student will separate mixture of liquids by fractional distillation.

B. The student will separate mixture of liquid and solid by decanting or filtering.

C. The student will separate mixture of solids by selective solubility, fractional crystallization, or paper chromatography.

D. The student will separate mixture of gases by selective solubility or liquifying followed by fractional distillation.

IV. Investigate and develop techniques of taking some pure substances (compounds) apart into simplest substances (elements).

A. The student will decompose some compounds by using heat.

B. The student will decompose some compounds by using heat and charcoal.

C. The student will decompose some compounds by using electricity.

D. The student will decompose some compounds by using acid.

V. Identify traces of certain elements through flame tests and spectral analysis.

VI. Through radioactivity to establish the discreatness of matter, the individual particles of matter become evident through individual dots on exposed film, tracks in cloud chamber and clicks of geiger counter.

VII. Investigate the building and using of scientific models and to specifically build an atomic model of matter (static).

A. The student will relate the method of model building through the "black box" experiments.

B. The student will develop the "law of multiple proportions" and the Law of Definite proportions" through "visible atoms" (paper fasteners and rubber rings) and extending to real atoms.

C. The student will investigate the closeness of atoms or molecules to one another in the different states of matter.

D. The student will measure indirectly the size and mass of an olric acid molecule.

E. The student will relate the size and mass of some atoms.

VIII. Investigate molecular motion and molecular model of heat.

A. The student will conclude through experiments that the molecules of a gas move.

B. The student will develop Boyles Law through "sphere gas" (agitated steel spheres) and extending to real gases.

C. The student will develop an association between molecular speed and temperature, first through the "sphere gas" and extending to real gases in fire syringe.

D. The student will be able to conclude that gases at extremely high pressures (greater than 150 atm) do not obey Boyle's Law and that under these big pressures compressibility and thermal expansion become characteristic properties for gases.

E. The student will define and measure calories of heat.

F. The student will be able to develop through experimentation the idea of specific heat.

G. The student will investigate processes in which heat is produced or absorbed during rearrangement of atoms in forming compounds, dissolving, melting and boiling.

RESOURCES:

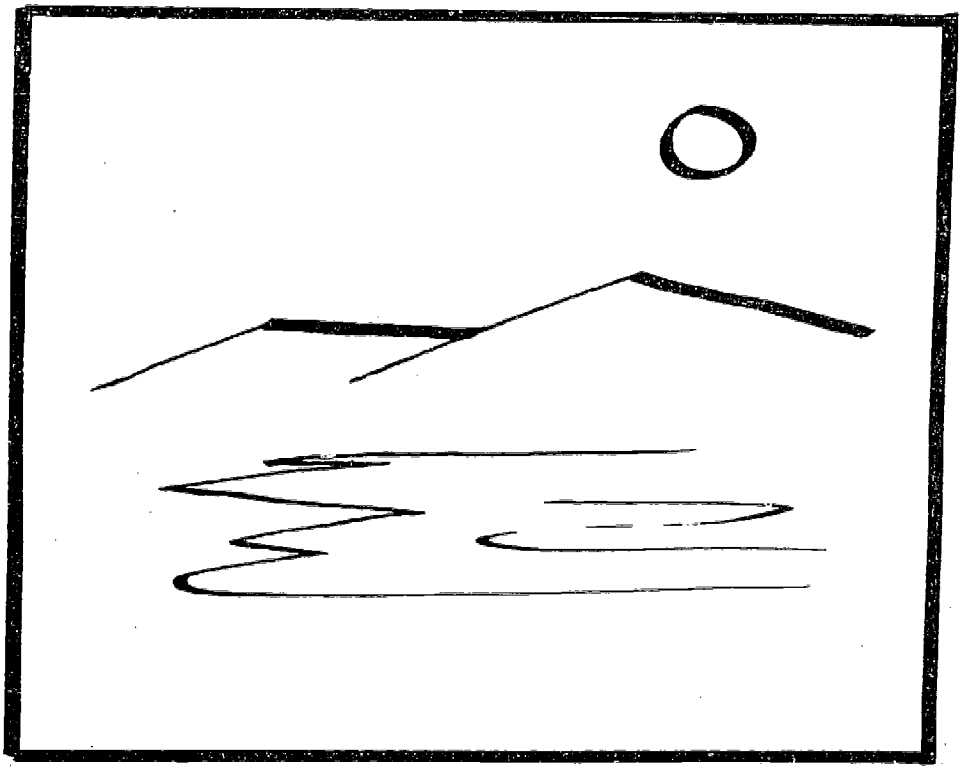
Books:

Discovering Chemistry - Cooper, Elizabeth K.; Harcourt, Brace & World, New York, 1959
Exploring Chemistry - Gallant, Roy; Doubleday, New York, 1958
The Story of Chemistry - Freeman, Mara and Ira; Random House, New York, 1962
Your Career in Chemistry - Esterer, Arnulf; Julian Messner, New York, 1964
Madame Curie - Currie, Eve; Doubleday, New York, 1948
Atomic Energy: The Story of Nuclear Science - Jaworski, Irene C. and Alexander, Joseph; Harcourt, Brace & World, New York
A Short History of Chemistry - Asimov, Isaac; Anchor Books, Garden City, 1965
The Physical World (3rd Edition) - Brinckerhoff, Richard et al; Harcourt, Brace & World, New York, 1938
A Star Called the Sun - Gamow, George; Viking, New York, 1964
The Glass Giant of Palomar - Woodbury, David O.; Dodd, New York, 1953
The Story of Cosmic Rays - Beiser, Germain & Arthur; Dutton, New York, 1962
The Sky Observer's Guide: A Handbook for Amateur Astronomers - Mayall, Newton et al; Golden Press, New York, 1959
William Huschel - Armitage, Agnes; Doubleday, New York, 1962
Pictorial Astronomy - Aeter, Densmow et al; Crowell, New York, 1963
Amateur Astronomers Handbook - Sidgwick, J. B.; MacMillian, New York, 1955
How to Make a Telescope - Texereau, Jean; Interscience, New York, 1957
The Picture History of Astronomy - Moore, Patrick; Grosset, New York, 1962
Antoine Lavoisier: Scientist, Economist, Social Reformer - McKie, Douglas; Abelard-Schumann, New York, 1952
Great Discoveries by Young Chemists - Kendall, James; Crowell, New York, 1953
Great American Scientists - Fortune, editors; Prentice-Hall, Englewood Cliffs, 1961
Man and the Chemical Elements - Friend, J. Newton; Scribner, New York, 1961

Elements of the Universe - Seaborg, Glenn T.; Dutton, New York, 1958
Discovering Chemistry - Cooper, Elizabeth; Harcourt, Brace & World, New York, 1959
Concepts in Chemistry - Greenstone, Arthur et al; Harcourt, Brace & World, New York, 1966
Careers and Opportunities in Chemistry - Pollack, Philip; Dutton, New York, 1960
Working with Atoms - Fusch, O. R.; Basic Books, New York, 1965

Films:

Elements, Compounds & Mistures, IPS Group
Definite and Multiple Proportions, IPS Group
The Mass of Atoms, IPS Group
Behavior of Gases, IPS Group
Crystals, IPS Group



# EARTH SCIENCE

GRADE NINE

EARTH SCIENCE

The student will be given the opportunity to appreciate, analyze and comprehand that the earth is not a static ball of clay but exists in a dynamic state, that all of the earth's activities are interrelated among themselves and with the solar system, the universe and man.

I. From Coal to a Diamond

Objective: The student will be given the opportunity to explain, through investigation and observation, the structure and origin of rocks and minerals that make up the earth's crust.

A. Minerals - The Basic Earth Material

1. The student will be able to describe the different layers of the earth.
2. The student will be able to explain the structure of an atom, molecule, element and compound.
3. The student will be able to distinguish that atoms make elements and molecules make compounds.
4. The student will be able to identify the various properties of a mineral (e.g., solid, hardness, cleavage, specific gravity, crystalline, etc.).
5. The student will be able to identify various minerals by simple identification tests and observation (e.g., color, luster, crystal shape, streak test, hardness test, cleavage test, etc.).
6. The student will be able to relate the importance of various minerals to man.

B. From Minerals to Rocks

1. The student will be able to explain the relationship between minerals and ores.
2. The student will be able to describe the various methods of ore formation.
3. The student will be able to relate the importance of the various ores to man (e.g., coal, oil).
4. The student will be able to describe the origin and structure of the three families of rock.
5. The student will be able to explain the rock cycle.

C. Measuring the Face

1. The student will be able to explain what is a topographic map.
2. The student will be able to explain the various symbols and formations on a topographic map.
3. The student will be able to use effectively the topographic map in finding various features.
4. The student will be able to relate the importance of the topographic map to man (e.g., hunting, road building, farming, navigation, etc.).

II. The Earth Movers

Objective: The student will be given the opportunity to explain, through investigation and observation, that the surface of the earth is being continually broken down by physical and chemical forces.

A. Weathered or Eroded

1. The student will be able to explain the differences between weathering and erosion.
2. The student will be able to describe the various types of weathering.
3. The student will be able to describe the various types of erosion.

B. Water and the Land

1. The student will be able to explain what the water cycle is and how it functions.
2. The student will be able to describe the relationship between ground water, surface water and water in the air and the water cycle.
3. The student will be able to explain the movement of various materials by surface water.
4. The student will be able to explain, describe and discuss weathering and erosion caused by water.
5. The student will be able to trace the formation of a river system from its beginning to its maturity.
6. The student will be able to describe the various glaciers and discuss the formation of these glaciers.
7. The student will be able to explain the various glacial-caused formations (e.g., matterhorns, moraines, throughs, etc.).
8. The student will be able to infer the importance of the glacial ages to man.
9. The student will be able to describe the origin of lake basins.
10. The student will be able to discuss the various means of destroying lakes, including fresh water lakes being converted to salt water lakes.

C. Work of the Wind

1. The student will be able to explain, describe, and discuss weathering and erosion caused by wind.
2. The student will be able to explain the movement of various materials by wind.

D. Where Does Man Fit In?

1. The student will be able to compare and contrast the forces that are destroying the earth and draw conclusions as to their importance to man.

III. The Changing Face

Objective: The student will be given the opportunity to explain, through investigation and observation, that the surface of the earth is being continually built up by physical and chemical forces.

A. The Crust Moves

1. The student will be able to explain the constructional force, diastrophism.
2. The student will be able to discuss the phenomena of faulting and folding using the corresponding terminology.

B. The Melting Pot

1. The student will be able to explain the constructional force, vulcanism.
2. The student will be able to identify the types of volcanoes and their life histories.
3. The student will be able to recognize the evidence of volcanic activity within a given area.

C. Mountains, Plateaus and Plains

1. The student will be able to relate geosynclines, isostasy and mountain origin with one another.
2. The student will be able to describe the theory of continental drift.
3. The student will be able to describe the various types of mountains and explain their life histories.
4. The student will be able to identify plains and plateaus and explain their formations.

D. The Earth Shakes

1. The student will be able to explain the causes of earthquakes.
2. The student will be able to explain the principle behind an earthquakes movement of the ground.
3. The student will be able to identify some of the areas where earthquakes are common.

E. Where Does Man Fit In?

1. The student will be able to compare and contrast the forces that are building the earth and draw conclusions as to their importance to man.

IV. Water, Water, Everywhere

Objective: The student will be given the opportunity to discover, through observation and investigation, that the sea and its basin possess life, structure and motion similar to that of the dry lands.

A. The Sea and its Floor

1. The student will be able to describe some of the scientific apparatus used to explore the seas.
2. The student will be able to define the chemical and physical make up of sea water.
3. The student will be able to describe the sea floor topography.

B. The Sea in Motion

1. The student will be able to explain the formation and location of ocean currents.
2. The student will be able to explain the formation and actions of ocean waves.
3. The student will be able to describe some of the shore features formed by waves and currents.

V. Footprints From the Past

Objective: The student will be given the opportunity to explain, through observation and investigation, the history of the earth using both fossil records and geologic records.

A. The Geologic Clock

1. The student will be able to identify the geologic eras and periods.
2. The student will be able to describe the use of fossils in determining a given area's age.

B. Putting the Pieces Together

1. The student will be able to deduce what geological events took place by analyzing the rock layers in a given area.

C. The Parade of Life

1. The student will be able to relate the possible ways a fossil may be formed.
2. The student will be able to make inferences that life has changed through time using fossil records.
3. The student will be able to trace the evolution of life through the eras and periods.

VI. The Sky's the Limit

Objective: The student will be given the opportunity to discover the earth's niche in an ever-changing solar system and universe.

A. Galaxies Galore

1. The student will be able to explain the use and workings of various astronomers tools.
2. The student will be able to explain the measurement of various characteristics of stars and distant galazies (e.g., distances, size, mass, density, colors, temperatures, etc.).
3. The student will be able to explain the theories of the expanding universe and the steady-state universe.
4. The student will be able to classify various stars and galaxies according to distance, shapes, size, etc.
5. The student will be able to discuss relativity with respect to the universe.

B. The Sun's Family

1. The student will be able to describe and explain the sun as a source of light and energy.
2. The student will be able to describe the planets of the solar system as to size, distance from the sun, orbit, shape, density, atmosphere, and surface termperature.
3. The student will be able to explain the origin and formation of meteors, meteroids and comets.
4. The student will be able to draw conclusions to whether there is life on other planets.

C. Man on the Moon

1. The student will be able to make inferences as to the importance of man's landing on the moon (e.g., future home for man, lunar research, food source for the future, space station for deeper space exploration).

2. The student will be able to explain the theory of the moon's formation.
3. The student will be able to discuss the structure of the moon.
4. The student will be able to relate the moon, the sun, and tide movement with one another.
5. The student will be able to explain the relationship between eclipses and the moon.

D. A Walk in Space

1. The student will be able to discuss the history of man in space.
2. The student will be able to explain the relationship between gravity, orbits and rocket propulsion.
3. The student will be able to deduce the problems a space voyager would have to overcome to journey from one planet to the next.

E. Motions of the Earth

1. The student will be able to prove the earth rotates using the Foucault Pendulum.
2. The student will be able to explain day length and seasonal change using the earth's rotation and revolution around the sun.

VII. Wind, Rain and the Coconut

Objective: The student will be given the opportunity to explain, through observation and investigation, what causes the day-to-day weather which surrounds him.

A. The Sun's Rays

1. The student will be able to list the layers which make up the atmosphere around the earth.
2. The student will be able to explain how energy from the sun is used to heat the atmosphere and the earth.
3. The student will be able to describe the plotting of air temperatures on maps.
4. The student will be able to operate the instruments used to measure air temperature.

B. The Force of Air

1. The student will be able to explain that the atmosphere has pressure.
2. The student will be able to explain and operate the instruments used to measure air pressure.
3. The student will be able to relate high and low pressure with different types of weather.
4. The student will be able to explain what the coriolis force is and its effects on wind direction.
5. The student will be able to express what winds are and how they originate.
6. The student will be able to describe the plotting of air pressure and winds on maps.
7. The student will be able to explain the three-cell theory in depth.

C. Water in the Air

1. The student will be able to explain that there are three states of

water which can be changed from one form to another by melting, freezing, evaporation, condensation and sublimation.
2. The student will be able to explain the process of evaporation.
3. The student will be able to relate what relative humidity is and how it can be measured.
4. The student will be able to explain the process of condensation.
5. The student will be able to relate condensation and dew point.
6. The student will be able to explain the process of cloud formation.
7. The student will be able to identify several different cloud formations.
8. The student will be able to explain the difference between fogs and smog.
9. The student will be able to discuss the theory of precipitation.
10. The student will be able to identify and explain the different forms and formations of precipitation.
11. The student will be able to operate the instruments used to measure precipitation.
12. The student will be able to explain why different areas have different amounts of precipitation.

D. Making of the Weather

1. The student will be able to explain the formation of different types of weather fronts.
2. The student will be able to explain the formation of different types of storms.

E. Why Coconuts Don's Grow in the North

1. The student will be able to list the factors that influence the climate in a given area.
2. The student will be able to classify the different climates of the world.

F. Where Does Man Fit In?

1. The student will be able to make inferences as to the importance of weather to man for his food, clothing, water, shelter, etc.

RESOURCES:

Books:

The Earth - Beiser, Arthur, 551 Bei
Earth-Age - Hurley, Patrick M., 550.1 Hur
Earth Science - Scientific American, 550 Sci, 1969
Earth Science - Scientific American, 1969, 300
The Earth's Story - Ames, Gerald, 553 A

Minerals: (Teacher References)
Economic Mineral Deposits - Bateman, A. M.; Wiley, New York, 1950
Getting Acquainted With Minerals - English, G. L., and Jensen, D. E.; McGraw Hill, New York, 1958
Miracle of Nature - King T.; MacMillan, New York, 1958
Field Guide to Rocks and Minerals - Pough, F. H.; Houghton Mifflin, Boston, 1953

Minerals: (Pupil References)
Earth's Adventures - Fenton, C. L.; John Day, New York, 1942
Riches From the Earth - Fenton, C. L. & M. A.; John Day, New York, 1953
Our Scientific Age (Singer Scientific Series) - Frasier, G. W., MacCrocker, H. D., and Decker, D. G.; L. W. Singer, Syracuse, New York, 1956
Our Scientific World (Singer Scientifif Series) - Frasier, G. W., MacCrocker, H. D., and Decker, D. G.; L. W. Singer, Syracuse, New York, 1956
Crystals and Crystal Growing - Holden A. and Singer, P. L.; Anchor Books, Doubleday, New York, 1960
Minerology and Some of Its Applications - Hurlbut, C. S., Jr.; Mineralogical Society of America, Harvard Universtiy, Cambridge, Mass.
1000 Million Years on the Colorado Plateau - Look, A.; Bill Press, Denver, 1955
Earth Science, The World We Live In - Namovitz, S. N. and Stone, D. B.; Van Nostrand, Princeton, New Jersey, 1960
The Earth, A Great Storehouse - Parker, B. M.; Row Peterson, Evanston, Ill., 1941
Modern Earth Science - Ramsey, S. and Burckley, R. E.; Holt, Rinehart & Winston, New York, 1961
Treasures of the Earth - Reinfeld, F.; Sterling, New York, 1954
Uranium and Other Miracle Metals - Reinfeld, F.; Sterling, New York, 1955
Rocks and Minerals (Wonder Books) - Rhoads, G.; Grosset and Dunlap, New York, 1950
Child's Book of Stones & Minerals - Swenson, J.; Maxton, New York, 1955
Diamonds - Zim, H. S.; Morrow, New York, 1959

Rocks:(Teacher Reference)
Textbook of Geology - Farrels, R. M.; Harper, New York, 1951
Principles of Geology - Gilluly, J., Waters, A. C. and Woodford, A. O.; W. E. Freeman, San Francisco, 1959
Introduction to Physical Geology - Longwell, C. R. and Flint, R. F.; Wiley, New York, 1955

Rocks: (Pupil References)
The First Books of Stones - Cormack, M. B.; Franklin Watts, New York, 1950
My Hobby is Collecting Rocks and Minerals - Jensen, D. E.; Children's Press, Chicago, 1956
All About Our Changing Rocks - White, A. T.; Random House, New York, 1953

Volcanoes: (Teacher References)
Volcanoes as Landscape Forms - Cotton, C. A.; Wiley, New York, 1952
My Experiments With Volcanoes - Jaggar, T. A.; Hawaiian Volcano Research Association, Honolulu, 1956
Crater Lake - Williams, H.; University of California Press, Berkeley, California, 1941
Volcanoes - Williams, H.; (Scientific American Reader) Simon and Schuster, New York, 1953

Volcanoes: (Pupil References)
Volcanoes New and Old - Coleman, S. N.; John Day, New York, 1946
Volcano - Galt, T.; Scribner, New York, 1946
Will Vesuvies Blow Its Top Again? - Hauser, E. O.; "Saturday Evening Post", February 11, 1956
Volcanoes Declare War - Jaggar, T. A.; Paradise of the Pacific, Ltd., Honolulu, 1945
All About Earthquakes and Volcanoes - Pough, F. H.; Random House, New York, 1953

Metamorphism:
Igneous and Metamorphic Petrology - Tuiner, F. J. and Verhoogen, J.; McGraw Hill, New York, 1951

Earthquakes and the Earth's Interior: (Teacher References)
The Birth and Development of Geological Sciences - Adams, F. D.; Dover, New York, 1954
Our Earth - Beiser, A.; Dutton, New York, 1959
About Earthquakes - Eiby, G. A.; Harper, New York, 1957
Seismicity of the Earth - Gutenberg, B. and Richter, C. F.; Princeton University Press, Princeton, New Jersey, 2nd Ed., 1954
Fundamentals of Physical Science - Krauskopf, K. B.; McGraw Hill, New York, 4th Ed., 1959
Physical Geology - Leet, L. D. and Judson, S.; Prentice Hall, Englewood Cliffs, New Jersey, 3rd Ed., 1958
The World in Space - Marschack, A.; Dell, New York, 1958
"Earthquakes in Kein County, California, During 1952", California Department of Natural Resources, Division of Mines Bulletin No. 171 - Oakeschott, G. B.; San Francisco, 1955
Elementary Seismology - Richter, C. F.; W. H. Freeman, San Francisco, 1958

Earthquakes and the Earth's Interior: (Pupil References)
Restless Earth - Wyler, R. and Ames, G.; Abelard-Schuman, New York, 1954

Structural Geology & Mountain Building:
The Cause of Mountain Building - An Enigma - Eardley, A. J.; American Scientist, June, 1957
Biography of the Earth: Its Past, Present and Future - Gamow, George; Mentor Books M-27 (paperbound), 1948
Fundamentals of Earth Science - Thompson, H. D.; Appleton-Century-Croft, 1960
Elements of Geology - Zumberge, J. H.; John Wiley, New York, 1958

Atmospheric Science:
Climatology - Haurwitz, B. and Austin, J. M.; McGraw Hill, New York, 1944
Weatherwise - Laird,C.A.; 11(4): 128-129, 1958 (Workshop for Weatherman)
A Selective Bibliography in Meterology - Layton, E.; Weatherwise, 11(4): 135-136 and 11(3): 96-102, 1958
Everyday Weather and How It Works - Schneider, H. and Bendick, J.; McGraw Hill, New York, 1951
Weathercraft - Spilhaus, A. F.; Viking, New York, 1951
An Introduction to Climate - Trewartha, G. T.; McGraw Hill, New York, 3rd Ed., 1954
Weather for a Hobby - Yates, R. F.; Dodd, Mead, New York, revised edition, 1946

Weathering:
Chemistry in Introductory Geology - Keller, W. D.; Lucas Bros., Columbia, Missouri, 1957
Principles of Chemical Weathering - Keller, W. D.; Lucas Bros, Columbia, Missouri, 1957
"Climate & Soil", Climate and Man (U.S. Dept. of Agriculture Yearbook) - Kellogg, C. E.; U.S. Government Printing Office, Washington, D.C., 1941
A Survey of Weathering Processes and Products - Reiche, Perry; University of New Mexico Press, Albuquerque, New Mexico, Revised Edition, 1950

Water, Its Reservoirs and Work: (Teacher References)
Landscape as Developed by the Processes of Natural Erosion - Cotton, C. A.; Wiley, New York, 2nd Edition, 1949

Floor of the Ocean - Daly, R. A.; University of North Carolina Press, Chapel Hill, 1942
Rainfall and Runoff - Foster, E. E.; McMillian, New York, 1948
Realms of Water - Kuenen, P. H.; Wiley, New York, 1955
Hydrology - Meinzer, O. E., ed.; Dover, New York, reprint, 1949
Science of the Sea for Current Science and Aviation - Funcus, H. J.; American Education Publications, Columbus, Ohio, 1952

Water, Its Reservoirs and Work: (Pupil References)
Water, U.S.D.A. Yearbook - U.S. Department of Agriculture; U.S. Government Printing Office, Washington D.C., pp. 1-218, 1955
Water Supply Paper Series - U.S. Geological Survey, U.S. Government Printing Office, Washington, D.C.
Science Experiences - Elementary School - Parker, B. M.; Row, Peterson, Evanston, Ill., 1952

Glaciers:
Glacial and Pleistocene Geology - Flint, R. F.; Wiley, New York, 1957
Principles of Geology - Gilbury, J., Waters, A. C. and Woodford, A. O.; Freeman, San Francisco, 1959
Geomorphology, The Evolution of Landscape - Hinds, N.E.A.; Prentice Hall, New York, 1943

Mineral Resources:
Principles of Economic Geology - Emmons, W. H.; McGraw Hill, New York, 2nd Edition, 1940
Encyclopidia of Science and Technology - McGraw Hill, New York, 1960
Non-Metallic Minerals - Ladoo, R. B. and Myers, W. M.; McGraw Hill, New York, 2nd Edition, 1951
Mining Geology - McKinstry, H. E.; Prentice Hall, New York, 1948
Oil in the Earth - Prott, W. E.; University of Kansas Press, 1943
Conservation of Natural Resources - Smith, G.; Wiley, New York, 2nd Edition, 1958

Astronomy: (Teacher References)
Astronomy - Baker, R. N.; Van Nostrand, Princeton, New Jersey, 7th Ed., 1959
A Short History of Astronomy - Berry, A.; Scribner, New York, 1899
Astronomy - Duncan, J. C.; Harpers, New York, 5th Ed., 1955
How to Use Your Telescope - Edmund Scientific Co., Barrington, New Jersey, 1959
Scientific American Reader - Simon & Schuster, New York, 1953, pp. 2-51.
Elementary Astronomy - Struve, O.; Oxford University Press, New York, 1959
Modern Space Science - Trinklein, F. E. and Huffer, C. M.; Holt, Rinehart & Winston, New York, 1961

Astronomy: (Pupil References)
Pictorial Astronomy - Alter, D. and Cleminshaw, C. H.; Cromwell, New York, 1956
When the Stars Come Out - Baker, R. H.; Viking, New York, 1954
Exploring the Distant Stars - Clason, C. G.; Putnam, New York, 1958
Through the Telescope - Fath, E. A.; McGraw Hill, New York, 1936
Exploring the Universe - Gallant, R. A.; Doubleday, New York, 1956
The Conquest of Space - Ley, W.; Viking, New York, 1949
Modern Space Science - Trinklein, F. E. and Huffer, C. M.; Holt, Rinehart & Winston, New York, 1961

Introduction to Paleontology:

Search for the Past, An Introduction to Paleontology - Beerbower, J. R.; Prentice Hall, New York, 1960

The Dinosaur Book - Colbert, E. H.; McGraw Hill, New York, 1951

Invertebrate Paleontology - Easton, W. H.; Harper and Brothers, New York, 1960

Invertebrate Fossils - Moore, R. C., Lalicker, C. G., and Fischer, A. G.; McGraw Hill, New York, 1952

Sedimentation:

Sedimentary Rocks - Pettijohn, F. J.; Harpers, New York, 2nd Ed., 1957

Sequence in Layered Rocks - Shrock, R. R.; McGraw Hill, New York, 1948

Principles of Sedimentation - Twenhofel, W. H.; McGraw Hill, New York, 2nd Ed., 1950

Films:

Crystals (black & white), 25 minutes; Educational Services, Inc.

In the Beginning, 1954, 28 minutes (sound, color); available from Modern Talking Picture Service

1955 Eruption of Kilauea (color), 20 minutes; available for transportation costs only from U.S. Geological Survey, Washington 25, D.C. or U.S. Geological Survey, Denver Federal Center, Denver 2, Colorado

Earthquakes (black & white), 16 mm sound, 10 minutes, Almanac Films

The Face of the Earth (sound color), 16mm, 12 minutes; Eneyclopedia Britannica Films

The Hidden Earth (sound, color), 16mm, 12 minutes; Encyclopedia Britannica Films

In the Beginning (sound, color), 16mm, 29 minutes, Magnolia Oil Company

Mountain Building (sound, black & white), 16mm, 11 minutes, Encyclopedia Britannica Films

The Unchained Goddess (sound, color), American Telephone and Telegraph Co., 59 minutes, free on loan

Wearing Away of the Land (black & white), 1 real, 10 minutes, Encyclopedia Britannica Films

Birth of the Soil (color), 1 reel, 10 minutes, Encyclopedia Britannica Films

Water Cycle (black & white), 10 minutes, Encyclopedia Britannica Films

Work of Running Water (black & white), 10 minutes, Encyclopedia Britannica Films

Limestone Caverns (color), 11 minutes, Coronet Films

Face of the Earth, No. 763 (color), 12 minutes, Encyclopedia Britannica Films

Understanding Our Earth: Glaciers (color), 10 munites, Coronet Films, 1952

"A" Is for Atom (color), 14 minutes, General Electric Film LIbraries

Birth of an Oil Field (color), 30 minutes, Shell Oil Company

Mining for Nickel (color), 43 minutes, Rothacker, Inc.

Prospecting for Petroleum (color), 23 minutes, Shell Oil Company, 1947

The Earth in Motion, Encyclopidia Britannica

Exploring the Universe, Encyclopedia Britannica

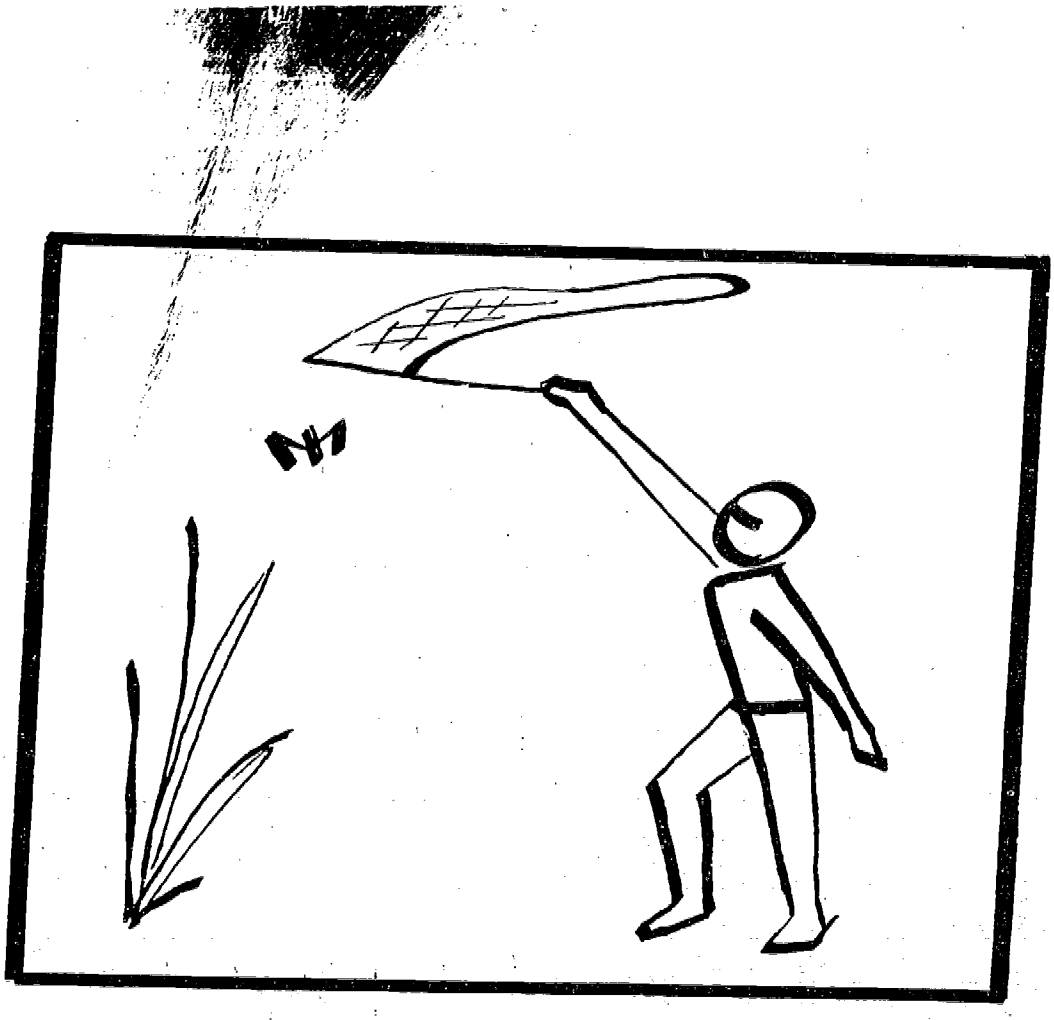
Exploring Space, Teaching Film Custodians

The Fossil Story (color), 19 minutes, Shell Oil Company

The Dinosaur Age (color), 13 minutes, Film Associates of California

Prehistoric Times: The World Before Man (black & white), 16 mm, 11 minutes, Coronet Instructional Films

The Bahamas Where Limestones Grow Today (color), 40 minutes, free on request from Humble Oil and Refining Company



# BIOLOGY

GRADE TEN

GENERAL BIOLOGY

I. Introduction to A.T. Biology

Objective: The student will demonstrate his understanding of the procedure and ideas behind individualized instruction, as well as what life is and the use of basic equipment necessary for laboratory use.

A. You should know about this first:

1. Each student will be able to operate the audio-visual equipment in the carrels.
2. Each student will be able to understand the routine procedure of check-in/check-out, recording work completed, grading, test taking, and use of demonstration materials.
3. Each student will be able to become familiar with lab procedure, individualized owrk, group seminar, and individual conference.

B. The Beginning and The End

1. Each student will be able to identify the three hypothesis of where life came from and contrast them with each other.
2. Each student will be able to define biogenesis and abiogenesis.
3. Each student will be able to formulate a workable definition of their own life.
4. Each student will be able to construct an outline of the early Renaissance history of life science leading to evolution and the cell theory.
5. Each student will be able to raise questions about organic evolution and whether it is probable and possible.

II. Ecology and Interaction

Objective: The student will demonstrate his understanding of the relationship of organisms to the environment by explaining various interactions between organisms in given communities.

A. Web of Life

1. Each student will be able to identify all of the physical factors of an environment and how their interaction effects the living things of ecosystem.
2. Each student will be ableto differentiate the various stages of the flow of energy and matter through ecosystem.
3. Each student will be able to relate what a producer, consumer, and decomposer are and how they interact to form a Food Web.
4. Each student will be able to write or recite the various parts of the carbon, sater, nitrogen, and mineral cycle in the transfer of matter in the system and compare the part each plays in the ecosystem.
5. Each student will be able to construct a mass and numbers pyramid for a simple ecosystem of living things.

B. Ocean to Mountain Top

1. Each student will be able to identify the major limiting factors of the various major biomes of the world.

2. Each student will be able to write or recite what all of the major biomes are and relate the major types of vegetation and animal life found in each of the biomes.
3. Each student will be able to compare at least two different biomes as to abiotic factors and biotic factors.
4. Each student will be able to relate suscession and climax in an ecosystem and the factors involved in causing these changes.
5. Each student will be able to identify the major problems that organisms face in living on land.
6. Each student will be able to contrast the effects of altitude and latitude upon the climax vegetation.

C. Life in a Pond

1. Each student will be able to identify the three water zones in a pond divided by the amount of light penetration.
2. Each student will be able to identify the various areas of the pond and the various organisms that can be found in this variety of habitate.
3. Each student will have a general knowledge of the animals and plants of the pond as to what they look like and where they may be able to find them, and how they make their living in the ecosystem.
4. Each student will be able to identify and use the various pieces of collection equipment to be used on a field trip.
5. Each student will be able to know and demonstrate the various procedures of collecting materials for all four-team assignments at the pond.

D. Field Study of a Pond

1. Each student will be able to undertake a field study of a pond, doing the collecting and sorting of biotic material.
2. Each student will be able to record and evaluate the abiotic factors from direct observation of the habitat.
3. Each student will be able to evaluate the interraltionship of biotic and abiotic materials that they observed, collected and recorded as to both food and energy chains, influencing factors outside the ecosystem, and pyramid of numbers.
4. Each student will be able to compare this studied food ecosystem with other ecosystems of the biosphere.

E. The Bomb - "Can Any of Us Escape?"

1. Each student will be able to identify the major pollution problems of our environment.
2. Each student will be able to relate the pollution problems to the major problem of over-population.
3. Each student will be able to compare the position of the individual to a population and how the population fits to a community.
4. Each student will be able to identify the parts of population dynamics and compare these to pollution and over-population.
5. Each student will be able to compare and contrast the basic principles of ecology with our present dilemma of pollution.

III. The Living Cell

Objective: The student will demonstrate his understanding of the structures of a cell and how these structures function as well as how a cell reproduces into two identical cells.

A. The Building Blocks of Life

1. The student will be able to write or recite the cell theory and the history that brought about its formation.
2. The student will be able to identify the part played by Hooke, Scheilden and Schwann, aided by the work of Verchow in the development of the cell theory.
3. The student will be able to identify the various parts of a cell and the locations of each.
4. The student will be able to compare the relationship of the size of a cell to its ability to carry on vital functions.

B. The Land of Diminishing Returns

1. The student will be able to write or recite the function of the following cellular parts:
   a. Nucleus.
   b. Chromatin.
   c. mitochondrin.
   d. Vacuole.
   e. Cell membrane.
   f. Endoplasmic reticulum.
   g. Ribosome.
   h. Nucleolus.
2. Each student will be able to relate how the nucleus controls the formation of protein.
3. Each student will be able to identify and compare the basic principle of active transport and its energy requirements to normal cellular diffusion.

C. Mitosis

1. Each student will be able to relate the general changes undergone by a nucleus through the four phases of mitosis, and identify each stage on a microslide of onion root and whitefish bastula.
2. Each student will be able to write or recite the major changes that occur in the nucleus during interphase, both visible and invisible.
3. Each student will be able to relate the two processes of equational cellular division and correlate the connection between the two.
4. Each student will be able to contrast several changes between plant and animal mitosis.

IV. The Energy to Run the Organic Machine

Objective: Given a chemical process necessary for organic life, the student will be able to explain and/or demonstrate the process and interrelate it to the other processes of life.

A. Energy, Matter and You

1. Each student will be able to define Energy.
2. Each student will be able to list the three states of matter and the differences in molecular motion.
3. Each student will be able to write or recite the definition of the chemical and physical properties of matter and give at least four examples of each one.
4. Each student will be able to compare potential energy with kinetic energy.

5. Each student will be able to relate the transformation of energy and matter from one form to another in three different instances.
6. Each student will be able to identify the basic structures of matter and the construction of atoms and molecules.
7. Each student will be able to compare the differences between elements, compounds and mixtures.

B. Energy in the Atom

1. Each student will be able to write or recite the three particles that make an atom.
2. Each student will be able to relate the attractive forces that hold the particles of the atom together.
3. Each student will be able to explain the concept of energy levels in relationship to the position of the electrons.
4. Each student will be able to construct a picture of the orbiting electrons and their positions to each other.
5. Each student will be able to contrast how atoms are constructed in relationship to 103 different elements.
6. Each student will be able to contrast the relationship between the electrons in the outer energy level and how chemical bonds form to make molecules.

C. The Carbon Atom

1. Each student will be able to construct the atomic structure of carbon.
2. Each student will be able to relate that carbon has four covalent bonds and that it shares electron pairs when it forms these bonds.
3. Each student will be able to write or recite a molecular formula and a structural formula for simple carbon molecules.
4. Each student will be able to contrast how carbon, because of it bonding, can form so many different molecules by forming straight chains, chains that form many geometric figures as well as rings.
5. Each student will be able to relate carbon will not only single bond with itself, but will double and triple bond with each other and become more reactive this way.

D. Carbon Compounds

1. Each student will be able to construct three basic carbon compounds that are common to all living things.
2. Each student will be able to identify the basic units that make up carbohydrates, fats, and proteins.
3. Each student will be able to identify and construct the basic simple sugars and bond them together to form the complex carbohydrates.
4. Each student will be able to construct glycerol and fatty acids, put the two together, and make up a lipid.
5. Each student will be able to construct amino acids, bonding them with peptid bonds to form protein molecules.

E. The Reason For Go

1. Each student will be able to define and give examples of potential and kinetic energy.
2. Each student will be able to describe the changes in entropy that changes in energy and organizations cause.
3. Each student will be able to write or recite what an endergonic and exergonic reaction is and compare the relationship to energy.
4. Each student will be able to define entropy and relate it to the dynamic equilibrium of a cell.

F. ATP Action

1. Each student will be able to identify the chemical structure of ATP.
2. Each student will be able to differentiate usable forms of energy inside a living cell.
3. Each student will be able to define a high energy bond and relate how the cell utilizes it to do work in ATP to ADP cycle.
4. Each student will be able to write and recite the basic types of cellular work and some examples of these in a cell.
5. Each student will be able to identify the action of ATP and relate how a muscle fiber performs work.
6. Each student will be able to relate the general energy cycle from the sun to ATP in a living cell.

G. The Production of Go

1. Each student will be able to define Radiant Energy.
2. Each student will be able to relate the function of chlorophyll to its structure and molecular change in trapping energy.
3. Each student will be able to recite or write the three pathways that light energy follow after being absorbed by the chlorophyll molecule.
4. Each student will be able to contrast cyclic and non-cyclic phosphorelation in their production of ATP during the light phase of photosynthesis.
5. Each student will be able to write or recite the general functioning of the dark phase of photosynthesis with the products and materials used in this phase.
6. Each student will be able to construct an overall picture of the entire process of photosynthesis and relate it to the energy requirements of all living things in an ecosystem.

H. Using Go for Life

1. Each student will be able to relate the respiratory process to photosynthesis, ATP, the mitochondris, and cell metabolism.
2. Each student will be able to describe the three major processes (glycolysis, Krebs Cycle, and electron transport system) and relate the transfer of energy from one to another.
3. Each student will be able to compare the likenesses and differences in aerobic and anaerobic respiration.

VI. Animals Without Backbones

Objective: To give the student a comparison and overall view of the various types of invertebrate animals.

A. One-Celled Organisms

1. Each student will be able to identify some common protozoans.
2. Each student will be able to describe the different means of movement of different protozoans.
3. Each student will be able to list the important structures and their functions.
4. Each student will be able to describe the reproduction of protozoans.

B. Hollow Bodied Animals

1. Each student will be able to relate how the multicellular condition permits efficient division of labor.

2. Each student will be able to list and define the major structural characteristics of sponges and coelenterates.
3. Each student will be able to relate the feeding and reproduction of both of these phyla.
4. Each student will be able to compare the likenesses and differences of the sponges with the coelenterates.
5. Each student will be able to make a comparison of the degree of all specialization that occurs in sponges and coelentrates.

C. Worms

1. Each student will be able to identify the general phylum characteristics of the three phyla of round, flat and segmented worms.
2. Each student will make a comparison between these three groups in structural, evolution, and way of life.
3. Each student will show and explain the great diversity of the various animals within these three groups.
4. Each student will be able to constrast and compare the highly organized systems of the earthworm with the simple ones of the planaria.

D. Soft-Bodied Animals

1. Each student will be able to identify the general characteristics of the phylum mollusca.
2. Each student will be able to relate the great diversity among the group of four classes as well as common characteristics of each class.
3. Each student will be able to identify the general body structures of the fresh water clams.
4. Each student will be able to identify and relate the general physiology of the animals digestion, circulation, respiration and nervous system.
5. Each student will be able to write or recite the life cycle and reproduction of the clam.
6. Each student will be able to compare the greatly specialized squid with the other members of the group.

E. Knights of "Olde"

1. Each student will be able to define and recite the general characteristics of arthopods.
2. Each student will compare and contrast the difersity among the animals in this phylum.
3. Each student will be able to identify the behavior responses from external environment.
4. Each student will be able to differentiate the structural adaptations in the appendages of this crustacean.
5. Each student will be able to identify the parts of the internal anatomy of the crayfish as a representative arthropod.
6. Each student will be able to write or relate some of the economic importance of this group to man.

F. Spiny-Skinned Creatures

1. Each student will be able to list the major characteristics of the phylum Echinodermate.
2. Each student will be able to describe the structure and way of life of the starfish.
3. Each student will be able to make a comparison of the Echinodermata at the transitional form of life between invertebrates and vertebrates.

VII. Simple Plants

Objective: Each student should be able to relate the general characteristics of the non-vascular plants and compare these in a phylogenic arrangement to the evolution of the plant kingdom.

A. The Small Ones - Virus and Bacteria

1. Each student will be able to relate in writing the following things about bacteria:
   a. Structure.
   b. Types.
   c. Size.
2. Each student will be able to relate the methods and conditions that bacteria are able to survive.
3. Each student will be able to relate the factors and conditions that have an effect on growth rate and reproduction of bacteria.
4. Each student will be able to list the nutritional requirements of a bacteria.
5. Each student will be able to discuss in paragraph form the two conditions of transformation and transduction.
6. Each student will be able to discuss the factors and conditions that relate bacteria or pathogens to diseases.
7. Each student will be able to relate the following things about antibiotics:
   a. Spectrum of influence.
   b. Specificity.
   c. Production.
   d. Control of bacteria.
   e. From where they come.
8. Each student will be able to relate the structure of a virus.
9. Each student will be able to relate the life cycle of a virus and explain the cycles relationship to living cells or hosts.

B. The First Green Ones

1. Each student will be able to relate the basic structure and compare it to the single-celled bacteria.
2. Each student will be able to compare and contrast the evolution of algae through the various forms and also with other plants.
3. Each student will be able to relate the various algae types, their life cycles and color of pigmentation.

C. Fungi

1. Each student will be able to identify the various types of true fungi and their life cycles.
2. Each student will be able to relate the basic structure of the fungi and their asexual and sexual forms of reproduction.
3. Each student will be able to have a visual identification of the many forms of fungi.
4. Each student will be able to relate an understanding of the involuntary relationship of fungi to protozoa and the simple green plants.
5. Each student will be able to contrast the economic importance of several of the forms to our everyday life in Montana.

D. Trend Toward Complexity

1. Each student will be able to compare the common structures of the simple green plants.
2. Each student will be able to contrast the evolutionary changes in the green plant from a water environment to the simplest land plants.
3. Each student will be able to write or recite the seven adaptions that are needed to occur to make survival possible for a green plant on land.
4. Each student will be able to compare and contrast the alternation of generations of algae and moss.
5. Each student will be able to relate how alternation of generations makes a plant more adaptable in a changing environment.

VIII. The Machine and How It Works

Objective: Each student should be able to identify the major systems and organs of the human body and apply their structure to the functioning of these systems.

A. Food and Where It Goes

1. Each student will be able to relate how the structural characteristics of the digestive process were developed from an evolutionary point of view.
2. Each student will be able to describe intracellular digestion and extracellular digestion.
3. Each student will be able to explain the importance of digestion.
4. Each student will be able to explain how the food is acted upon from the time it gets into the mouth until it reaches the large intestine.

B. The Pump and Transportation

1. Each student will be able to write or give orally two major functions of the circulatory system.
2. Each student will be able to reconstruct the evolutionary development of the circulatory system.
3. Each student will be able to contrast and compare an open circulatory system with a closed system.
4. Each student will be able to trace the flow of blood through the heart, naming the parts in succession.
5. Each student will be able to relate the components of blood to their function.
6. Each student will be able to list the characteristics and function of the arteries, veins, and platelets.
7. Each student will be able to trace the clotting process.

C. Clean Air and Water

1. Each student will be able to relate an evolutionary and structural comparison of both systems in animals.
2. Each student will be able to relate the three main organ systems utilized by complex animals and how they work in moving oxygen to cells.
3. Each student will be able to compare the needed structural changes in lung tissue of the various vertebrate animals.
4. Each student will understand the structure and mechanics of the breathing process in humans.
5. Each student will be able to describe the three basic nitrogen wastes and the importance of each in their removal from the living animal.

6. Each student will be able to recognize other systems in the human that perform an excretory function other than the kidney.
7. Each student will be able to relate the basic structures of the excretory system as well as the structure of the kidney.
8. Each student will have an understanding of the filtration and reabsorption process as to how they are performed and the products involved, since the basic physiology of the human kidney is important.

D. Control, Circuits and Cerebrum

1. Each student will be able to identify as to structure and function the major areas of the central nervous system.
2. Each student will be able to explain the workings of a simple reflex arc.
3. Each student will be able to describe the effects of the controls centers of the various autonomic functions of the body.
4. Each student will be able to compare the advance in evolutionary development of simple invertebrate systems to man.
5. Each student will be able to express and demonstrate how the electric chemical movement of an impulse occurs along a neuron and across a synapse.
6. Each student will be able to relate how the nervous system with the endocrine system controls certain functions of the organisms.
7. Each student will identify what a hormone is and how it performs as a chemical messenger with a built-in feed back mechanism.

E. Muscles

1. Each student will be able to compare and contrast the three major types of muscle tissue found in most mammals.
2. Each student will be able to construct a picture of a section of a myofibril and label the various bands.
3. Each student will be able to construct a picture of the gross anatomy of a muscle and label the parts.
4. Each student will be able to describe why, when he looks at a skeletal muscle, he sees striations and describe what makes up the striations.

F. About Birds and Bees

1. Each student will be able to follow a pattern of sexual reproduction through the animal kingdom, seeing many differences, but deducing a common pattern in all.
2. Each student will be able to compare the differences in external and internal fertilization.
3. Each student will be able to describe the various patterns of reproduction within the mammals.

G. Development

1. Each student will be able to derive, through comparisons with the frog and chick development, an understanding of early human development.
2. Each student will be able to identify the various changes that occur in early embryonic development.
3. Each student will be able to identify the three embryonic tissues and what major systems develop from each.
4. Each student will be able to describe the changes that are undergone in the uterus after fertilization has occurred.

5. Each student will be able to discuss and compare the basic pattern of embryonic development in all vertebrate animals as an evolutionary trend in the development of mammals.

IX. The Land Turns Green

Objective: Each student should have an understanding of vascular plants and relate their structures and life cycles on an evolutionary basis with the lower plants.

A. Vascular Plants Take Over

1. Each student will be able to describe the general characteristics of vascular plants.
2. Each student will be able to draw some conclusion from the fossil record of vascular plants in demonstrating the evolutionary advances from these to our present-day angiosperms.
3. Each student will be able to relate the fossil and isolated living remnants of past groups to the modern ferns and mosses.
4. Each student will be able to identify and develop the life cycle of a fern and a moss.

B. Forever Green

1. Each student will be able to describe the alternation of generations of gynmosperms.
2. Each student will compare the structural and functional changes that have evolved from earlier vascular to the gymnosperms.
3. Each student will realize how gymnosperms provide useful resource to our civilization.

C. Daisies

1. Each student will be able to develop through evidences of the characteristics of the simpler plants a theme that will explain how the flowering plants became the dominate plant.
2. Each student will be able to relate the cycle of flower plants through likenesses and differences with other plants.
3. Each student will be able to explain how specialized structures that have come from evolution have better adapted the flowering plants to survive the environment.

D. Three Musketeers

1. Each student will be able to identify the major parts or roots, stems, and leaves.
2. Each student will be able to discuss the functioning of the major tissues of roots, stems and leaves.
3. Each student will be able to identify some of the important cell types and how their structures adapt them to do a particular function within the plant.
4. Each student will be able to collect and identify a few basic flower plants by vegetative structure.

E. The Forbidden Apple

1. Each student will be able to identify the basic structures of the flower.

2. Each student will be able to relate the processes of pollination, fertilization and seed development.
3. Each student will be able to describe the alternation of generations of flower plants.
4. Each student will be able to relate the various structures and types of fruit and seeds.

X. Heredity

Objective: Each student should be able to identify chromosomes and relate these cellular structures to Mendelian genetic principles to solve simple genetic problems of the monohybrid and dihybrid types.

A. Thread of Life

1. Each student will be able to relate orally or in writing the following things about the DNA molecule:
   a. The three units that make up the DNA molecule.
   b. The four different nitrogen bases.
   c. How these units are put together.
   d. The coded arrangement of the bases.
2. Each student will be able to describe the process of replication or duplication of the DNA molecule.
3. Each student will be able to relate DNA code control in the nucleus to the building of a protein at the ribosome.
4. Each student will be able to describe what a mutation is in relation to a change in DNA.

B. Cell and Chromosomes

1. Each student will be able to define the following terms:
   a. Gene.
   b. Chromosome.
   c. Tetrad.
   d. Synapsis.
   e. Centromere.
   f. Spindle.
   g. Centrosome.
2. Each student will be able to define the fundamental stages of meiosis and the physical changes that occur in the cell.
3. Each student will be able to compare and contrast meiosis with mitosis.
4. Each student will be able to relate what happens to the chromosomes in meiosis to the genetic explanation of Mendel's Law.
5. Each student will be able to explain how the chromosome number goes from diploid to haploid in the formation of a gamete (redution division).
6. Each student will be able to explain that genetic continuity and variability are the physical happenings of meiosis.
7. Each student will be able to relate how mutation in cells occurs during the meiotic process.

C. Before Conception

1. Each student will do a cross involving one trait or a monohybrid cross.
2. Each student will be able to calculate and write the phenotypic and genotypic ratios for that cross.

3. Each student will be able to relate some of the definitions that are basic to genetics, such as homozygous, heterozygous, genotype, phenotype, dominant, recessive, and alleles.
4. Each student will be able to define Mendel's first law of genetics.
5. Each student will be able to discuss Mendel's work and its contribution to modern genetics.
6. Each student will be able to relate how the gene pairs are selected by each parent and the process involved, plus the recombination of them and what it will produce for that trait in the offspring.

D. How It All Happened

1. Each student will be able to recite and explain Mendel's second law of Independent Assortment.
2. Each student will be able to describe the relationship in combining the information of monohybrids crosses to work dihybrid problems.
3. Each student will be able to solve dihybrid corsses using the branched diagram method.
4. Each student will be able to explain the following things, how they take place, and solve problems concerning these:
   a. Sex-determination.
   b. Sex-linked traits.
   c. Sex-mosiacs.
   d. Polyploid.
5. Each student will be able to apply the process of crossing over to explain the variability that can occur among linked genes.
6. Each student will be able to identisy other physical changes that occur in chromosomes that cause mutations in the organisms.

XI. Evolution

Objective: Each student should be able to explain that the continuity of life is maintained by natural selection, and that there is an evolutionary relationship among living things supported by scientific evidence.

A. Darwin, Survival and Other Things

1. Each student will be able to relate a brief history of Darwin and the events that were instrumental in the solving of the theory of evolution.
2. Each student will be able to discuss Darwin's hypothesis of natural selection and some of the evidence to support it.
3. Each student will be able to evaluate the evidences of genetics as to supporting natural selection.
4. Each student will be able to explain the elemental forces of evolution.

B. Creatures of the Past and Present

1. Each student will be able to describe the fossil evidences and how it relates to evolution.
2. Each student will be able to compare geographic distribution with how the elemental forces have effected the living populations of a region.
3. Each student will be able to explain the effects of frequencies of alleles on changing populations.

C. Monkeys to Man

1. Each student will be able to describe and discuss the evolutionary evidence of man's ancestry.
2. Each student will be able to discuss the various forms of near man and early man and the differences as related to man today.
3. Each student will be able to describe the evidences of tools and culture of man in the evolutionary pattern of his development.
4. Each student will be able to give an evolutionary explanation of how the various race of modern man could have come into existance.

RESOURCES:

Books:

Understanding Chemistry - Lessing; New American Library
Matter, Energy, and Life - Gaker and Allen; Addison-Wesley
Inside the Living Cell - Butler; Basic Books
The Atom, A Simplified Description - Bush and Silvidi; Barns & Noble, 1961
Elementary Biophisics - Chapter 2 - Epstein; Addensen-Wesley, 1963
Little Animals - Dobell; Dover
This Is Life - Johnson; Steer, pp. 317-399
The Origin of Life - Oparim; Dover, 1957
On Men & Stars - Shaply; Bearen Press, 1952
The Earth is Born - Cat. No. 523.1
The Science of Biology - Weisz, Chap. 3., pp. 39-46.
Microbe Hunters - DeKruit; Harcourt and Brace
Pasteur and Modern Science - Dubos; Basic Books
Harvard Case Histories of Experimental Science
Animals Without Backbones - Bushsbaum
Microbial Life - Sistram; Prentice Hall
Microbiology - Anderson
Virus and Man - Burney; Penguin
Beyond the Microscope - Smith; Penguin
Micro Biology - Peltran
Dynamics of Development - Rugh; Harcourt and Brace
Growth and Development - Sussman; Prentice Hall
Development - Barth; Addison-Wesley
Animal Structure and Function - Griffin-Holt
Experiments and Observations on the Gastric Juice and the Physiology of Digestion - Beaumont
Life: An Introduction to Biology - Simpson and Beck; Harcourt, Brace & World
The Human Body: Its Anatomy and Physiology - Best and Taylor; Holt, Rinehart and Winston
Respiration - P. Dejours; Oxford University Press
The Vertebrate Body - Alfred S. Romer, 3rd Edition
General Zoology - Storer, Tracy I. and Usinger, Bob; McGraw Hill, 4th Ed.
How Animals Move - J. Gray; Cambridge University Press
Reproductive Physiology - Nalbandov, A. V., 2nd edition
Heredity and Development - Moore, John A.; Oxford Universtiy Press
Vertebrate Embryology: The Dynamics of Development - Rugh, Robert; Harcourt, Brace & World
Principles of Development and Differentiation - Waddinton, C. H.; MacMillian
Molecular Biology and the Chemical Control of Living Cells - Prentice Hall
Of Molecules and Man - Crick, F. H. C.; University of Washington Press, 1966
The Double Helix - Watson, James D.; Theneum, 1968
Experiments in Plant Hybridization - Mendel, Gregor; Harvard University Press, 1963
Principles of Genetics - Sinett, E. W., Dunn, L. C., and Dobzhansky, T.; McGraw Hill, 1959
The Mechanics of Inheritance - Shahl, F. W.; Prentice Hall, 1964

Heredity and Development - Moore, John; Oxford University Press, 1963
Molecular Biology of the Gene - Watson, J. D.; W. A. Benjamin, Inc., 1965
Biological Science for High School - Gregory, William H., 574 Gr
The Biological Time Bomb - Taylor, Gordon Rattray, New American Library, 1968, p. 239, 612 Tay
American Institute of Biological Sciences - 574 Ame
Biology - Ames, Gerald, 574 Ame
Biology - Brandwein, Paul F., 574 Br
Biology - Epstein, Herman T., 574 Eps
Biology - Gregory, William H., 574 Gr
Biology - Hardin, Garrett James, 574 Ha
Biology - Heiss, Elwood D., 574 He
Biology - Hoffman, Katherine B., 570 Hoff
Biology - Jaques, H. E., 574 Ja
Biology - Johnson, Willis H., Ed., 574 Joh
Biology - Kirk, John T., 574 Kir
Biology - Lehninger, Albert L., 574 Leh
Biology - Morgan, Ann Haven, 574.92 Mor
Biology - Scientific American, 574 Ame
Biology - Sigel, M. Michael, 574 Sig
Biology - Simpson, George Gaylord, 574 Sim
Biology - Smith, Ella Thea, 574 Sm
Biology - Taylor, William T., 574 Tay
Biology - Vessel, Matthew, F., 574 Ves
Biology - Von Frisch, Karl, 574 Von
Biology - Watsen, James C., 575.1 Wat
Biology - Weisz, Paul B., 574 We
Biology - Woolridge, Dean E., 574 Woo
Biology - Dictionaries - Abercrombie, M., 574.03 Ab
Biology - Dictionaries - Reinhold, 1961, 570.3 Gra
Biology - Dictionairs - Kenneth, John, 574 Ken
Biology - Experiments - Ramsay, James Arthur, 574.072 Ra
Biology - Fresh Water - Brown, E. S., 574.92 Gro
Biology - Fresh Water - Pennak, Robert W., 574.92 Pen
Biology - Marine - Idyll, C. P., 574.92 Idy
Biology of the Protozoa - Calkins, Gary, 593 Cal
Biophysics - Morowitz, Harold J., 574 Mor
Physiology - Asimov, Isaac (human body), 612 Asi
Physiology (human brain) - Asimov, Isaac, 612 Asi
Physiology - Best, C. H., 612 Be
Physiology - Burgdorf, Otto P., 612 Bur
Physiology - Carlson, Anton J., 612 Ca
Physiology - Lauber, Patricia, 612 Lau
Physiology - Morrison, Thomas F., 612 Mo
Physiology - Nourse, Alan E., 612 Nou
Physiology - Rogers, Terence A., 612 Rog
Physiology - Smith, Anthony, 612 Smi
Physiology - Tokay, Elbert, 612 Tok
Physiology - Tuttle, W. W., 612 Tut
Physiology - Williams, Jesse F., 612 Wil
Physiology - Zoethout, William D., 612 Zoe
Silent Spring - Carsom
The Sea Around Us - Carson
The Edge of the Sea - Carson
Ecology - Time Lifebooks
The Cell - Swanson; Prentice Hall
Inside the Living Cell - Butler; Basic Books

The Living Cell - See American Reprints, Freeman
Atoms, Molecules and Chemical Changes - Grunewald and Johnson; Prentice Hall
The History of Science - Dampier, William; Cambridge University, 1952
Anton Von Leuwenhock and His Little Animals - Dobell, Clifford; Russell & Russell, Inc., 1958
The Cell & Protoplasm - Moulton, F.; The Science Press, 1940
Unresting Cells - Guard, R. W.; Harper & Brothers, 1949
The Stuff We're Made of - Kermack, W., & Eggleston, P., Longmans Green & Co., 1948
The Elements: Builders of the Universe - Mayer, Jerome S.; World
The Cell - Swanson, Foundation of Modern Biology Series, Prentice Hall
The Plant Kingdom - Bold - Foundation of Modern Biology Series, Prentice Hall
Flora of Montana - Booth, Montana State College, Bozeman
Mammals of North America - Cahalane, Victor H.; MacMillian Co.
Reptiles of North America - Ditmar, Raymond L.; Doubleday & Co.
Snakes of the World - Ditmar, Raymond L.; MacMillian Co.
Taxonomic Keys to the Common Animals of the North Central States - Eddy, Samual and Hodson, A. C.; Burgess Pub., Co., 1955
Ward and Whipple's Fresh-Water Biology - Edmondson, W. T., ed.; Wiley, 1959
Animal Diversity - Hanson; Foundation of Modern Biology Series, Prentice Hall
The World of Plant Life - Hylander, Clarence; MacMillian Co.
Illustrated Keys to Plant & Animal Groups, "Meet the Natives" - Jaques, M. E., 372 S. Humbolt St., Denver, Colorado
Freshwater Invertebrates of the U.S. - Pennak, Robert W.; Ronald Press, 1953
Guide to Western Birds - Peterson, Roger, Field, T. A.; Houghton Mifflin Co., 1961
1001 Questions Answered About Trees - Platt, Rugherford; Dodd, Mead & Co.
The Tree Identification Books - Symonds, George W.; M. Barrows & Co.
Insects: A guide to Familiar American Insects - Zim, Herbert S. & Cottam, Clarence; Simon and Schuster, Inc.
Man Against Guns - Baron, A. L.; E. P. Dutton & Co.
Biology and World Health - Grant, Madeliene P.; Abelaird-Schuman
Medicine in Action - Hyde, Margaret; McGraw Hill Co.
Healthier Living - Schifferes, Justice J.; John Wiley & Sons
Guide for the Montana School Health Program - State Board of Health, Helena, Montana
The Machinery of the Body - Carlson, Anton J., and Johnson, Victor; University of Chicago Press, 4th Edition
Animal Behavior - Dethier, Stitlar; Foundations of Modern Biology Series, Prentice Hall
Animal Physiology - Knut, Schmidt Mielsen; Foundations of Modern Biology Series, Prentice Hall
Cellular Physiology and Biochemistry - McElroy; Foundations of Modern Biology Series, Prentice Hall
Plant Physiology - Meyer, Bernard S. and Anderson, Donald B.; D. Van Nostrand, 2nd edition
The Science Book of the Human Body - Sproul, Edith E.; Franklin Watts, Inc., 1955
Animal Growth & Development - Sussman; Foundations of Modern Biology Series, Prentice Hall
How Life Began - Alder, Irving; John C. Day Co., 1958
Heredity - Bonner; Foundations of Modern Biology Series, Prentice-Hall
Evolution, Genetics and Man - Dobzhansky, Theodosius; John Wiley & Sons, 1955
Genetics Is Easy - Guidstein, Philip, Lantern Press, 1955, 2nd Edition
The Human Heredity Handbook - Schienfeld, Amron; J. B. Lippincott Co., 1956
Principles of Heredity - Senott, Edmund W. et al; D. C. Heath & Co., 1956, 5th edition
Gregor Mendel: Father of the Science of Genetics - Sootin, Harry; Vanguard Press, Inc., 1958

Adaption - Sib, Wallace; Foundations of Modern Biology Series, Prentice Hall
Better Plants and Animals - U.S. Department of Agriculture, Superintendent of Documents, Government Printing Office, Washington D.C., 1937
Historical Geology - Dunbar, Carl O.; John Wiley & Sons, 1949
The Fossil Book: A Record of Prehistoric Life - Fenton, Carroll L.; Doubleday & Co., 1958
The Rock Book - Fenton, Carroll L.; Doubleday & Co., 1940
Life Long Ago: The Story of Fossils - Fenton, Carroll L.; John Day Co., 1937
Minerals for Atomic Energy - Nininger, Robert D.; D. Van Nostrand Co., 1956
A Field Guide to Rocks & Minerals - Paugh, Frederick H.; Houghton Mifflin Co., 1955
Life of the Past - Simpson, George G.; Yale University Press, 1953
Elements of Soil Conservation - Bennett, H. H.; McGraw Hill, 1947
Biological Conservation - Black, John D.; McGraw Hill, 1954
America's Natural Resources - Callison, Charles H., ed.; Ronald Press, 1958
Conservation in American Schools Yearbook - AASA, National Education Assoc., 1201 16th St., N. W., Washington D. C.
Conservation Pamphlets - Superintendent of Documents, Government Printing Office, Washington 25, D.C.
Wildlife Management - Gabrielson, Ira N.; MacMillian Co., 1951
Conservation in the U.S. - Gustafson, A. F. et al; Comstack Publishing Assoc., 1949
Conservation in America - Hogner, Dorothy; J. B. Lippincott, 1958
Natural Resources - Huberty, Flock; McGraw Hill
The Conservation of Montana's Natural Resources: A Handbook for Montana School Teachers - Montana Conservation Council, Montana State University, Missoula, 1953
Fundamentals of Ecology - Odum, E. P.; Saunders, 1933
Yearbook of Agriculture - Plant Diseases - U. S. Govt. Printing Office
Teachers Reference Guide to Montana History, Geography & Government - State Department of Public Instruction, Helena
Trees - Yearbook of Agriculture, U.S. Government Printing Office
Trees Native to Montana - Extension Service, M.S.C., Bulletin 257, 1956
Water - Yearbook of Agriculture, U. S. Government Printing Office
Youth Can Help Conserve These Resources - Soil, Water, Woodland, Wildlife, Grass - Soil Conservation Service, MSDA Information Bulletin 52, 1951

Films:

The Intertidal Region (loop film), 574 Lif
The Intertidal Region, 574 Int
Mimicry, 574 Mim
Desert, 551.4
The Creature of the Sea, 591.92
The Miracle of the Sea, 574.92
Tundra, 919.8a
Rain Forest, 918.8
Canopy of Air, 533b
Fresh Water Life, 574.92b
Fresh Water Life, 574.82c
Fresh Water Life, 574.92d
Fresh Water Life, 574.92e
The Atom, 541.2e
Atoms and Molecules, 541.2f
Metamorphasis, 591
Life in the Desert, 590b
Pasteur, The Benefactor, State Film Library

Introduction to Biology - State Film Library
What is Science? - State Film Library
Cell - The structural Unit of Life, State Film Library
Cell Division and Growth, Abbott Laboratories, Chicago, Ill.
Protoplasm - The Beginning of Life, Bray Studios, New York
The Parade of Invertebrates (4 films), Iowa State University
Characteristics of Plants & Animals, State Film Library
Body Defenses Against Desease, State Film Library
Antibiotics, State Film LIbrary
Body Fights Disease, State Film Library
Cancer, State Film LIbrary
Defending a City's Health, State Film LIbrary
Immunization, State Film Library
Alimentary Tract, State Film Library
Animals & Their Foods, State Film Library
Digestion of Food, State Film LIbrary
The Ear and Hearing, State Film Library
Heart and Circulation, State Film Library
Human Body: Skeleton, State Film LIbrary
Reactions in Plants & Animals, State Film Library
Heredity, State Film LIbrary
Heredity in Animals, State Film Library
Mitosis & Meiosis, State Film Library
The Fossil Story, State Film Library or Shell Oil
Hunting Animals of the Past, State Film Library
Prehistoric Animals of the Tar Pits, State Film Library
Web of Life, U.S. Forest Service
Ants, State Film Library
Animals and Their Homes, State Film Library
Bee City, State Film Library
Theatre of the Sea, Florida Development Commission
Soil Conservation Films, Soil Conservation Service
Forest Service Films, U.S. Forest Service
Field Trip to a Fish Hatchery, State Film Library
Bird Control, State Film Library
Yours Is The Land, State Film Library
Conservation Series, State Film Library:
- The Birth of the Soil
- This Vital Earth
- Arteries of Life
- Seeds of Destruction

Filmstrips:

Koch, Pasteur, Reed, Curie, etc., Metropolitan Life Insurance Co.
Health Heroes (series), Metropolitan Life Insurance Co.
Fighting Disease, Popular Science Publishing Co.
Life in Ponds, Lakes & Streams (series), 2821 E. Grand Blvd. Jam Handy, Detroit 11, Michigan

GRADES ELEVEN OR TWELVE

ADVANCED BIOLOGY

I. Develop an understanding of bio-chemistry.

Objective: The student should be able to explain or demonstrate the various biochemical processes necessary to maintain life.

A. The student will be able to explain the basic inorganic reactions that are related to life.
B. The student will be able to discuss the atomic theory, quantam theory and its relationship to energy.
C. The student will be able to discuss the chemical processes that led to the theoretical origin of life.
D. The student will be able to describe the structure and formation of the simple and complex organic compounds.
E. The student will be able to describe the structural framework of enzymes and relate this to the action of the enzyme in chemical reactions.
F. The student will be able to explain the step-by-step reactions that are called glycolysis, Krebs Cycle and Electron Transport System.
G. The student will be able to relate the similarities and differences in aerobic and anaerobic respiration in both plants and animals.

II. Develop an understanding of cytology.

Objective: The student should have an understanding of the basic structure and function of cells and the similarity of these and all species of plants and animals.

A. The student will be able to explain and identify the structure of plant and animal cells.
B. The student will be able to discuss the functioning of the various parts of living cells.
C. The student will be able to relate the process of protein synthesis to the cellular structure.
D. The student will be able to relate the processes of diffusion, osmosis and active transport to the cell membrane.

III. Develop an understanding of continuity of life.

Objective: The student should be able to demonstrate the continuity of life by explaining the process of reproduction in both plants and animals.

A. The student will be able to discuss and describe in detail the process of mitosis and how it maintains the continuity of life.
B. The student will be able to explain the likenesses and differences in mitosis and meiosis.
C. The student will be able to relate the process of meiosis with sexual reproduction.
D. The student will be able to relate and explain the process of DNA replication with the chromosomal pattern of heredity.
E. The student will review and have a knowledge of the basic Mendelian Laws.
F. The student will be able to apply Mendels Laws and be able to use these in the solution of genetic problems.
G. The student will be able to relate the process of natural selection to continuity of life.

G. The student will be able to describe asexual forms os reproduction and their relationship to the continuity of life.

IV. Develop an understanding of homeostasis.

Objective: The student should have an understanding of regulation and homeostasis by being able to explain how systems function to maintain a stable internal environment.

A. The student will be able to explain how various regulatory centers in the brain function to maintain homeostasis.
B. The student will be able to discuss and describe the action of guard cells and xylem tissue in the conductivity of water up the stems and root systems of plants.
C. The student will be able to describe the regulatory functions of the kidney in water and mineral balance as well as removal of nitrogen wastes.
D. The student will be able to explain and/or relate the action of the endocrine system with the central nervous system in the maintenance of stable environment.
E. The student will be able to explain the various systems within the blood to help maintain homeostasis.
F. The student will be able to describe the action of auxins within plants to create various trophism reactions in maintaining a stable environment.

V. Develop a knowledge of behavior.

Objective: The student should demonstrate an understanding of behavior in terms of the functioning of the organisms.

A. The student will be able to describe the action on the functioning of a receptor.
B. The student will be able to explain the action of a nerve impulse along a neuron and across a synaptic gap.
C. The student will be able to explain a reflex arc.
D. The student will be able to discuss the effect of chemical messengers on behavior patterns.
E. The student will be able to indicate a basic understanding of how nerve impulses are capable of transmitting specific information to a nerve center.
F. The student will be able to discuss some theories on how information is stored and then retrieved from the central nervous system.
G. The student will be able to express a knowledge of the simple behavior patterns of instinct, implanting, etc.

VI. Develop a knowledge of changing living things.

Objective: The student should understand the change of living things through time by explaining how organic processes can cause changes in organisms.

A. The student will explain how sexual reproduction occurs and how it causes changes in the organism.
B. The student will be able to demonstrate by example how isolation of populations cause changes in organisms.
C. The student will be able to discuss how green plants have changed in their development both vegetatively and sexually.

D. The student will be able to describe and discuss how the various chromosomal abberations create change in the organism.
E. The student will be able to explain how, with selective breeding, man has changed various organisms within civilized time.
F. The student will be able to explain the effect of mutation at the molecular level and relate this to the formation of proteins.

VII. Develop an appreciation for unity with diversity.

Objective: The student should be able to compare the structures and processes in different phyla that are similar to demonstrate the unity in pattern yet diversity in type.

A. The student will be able to explain the unity with the trend toward complexity in the transportation systems of plants and animals.
B. The student will be able to discuss unity of all things in the structure and function of DNA and RNA.
C. The student will be able to explain unity of respiratory organs between land and water animals.
D. The student will be able to summarize the embryonic pattern of vertebrate animals showing the great unity in each development, with the great diversity of the organisms.
E. The student will be able to describe and discuss the pattern in both structure and function of digestion in plant and animals.
F. The student will be able to describe the similarity in pattern of skeletal and muscular systems in invertebrate and vertebrate animals.
G. The student will be able to describe the unity of pattern in sexual reproduction of living things.

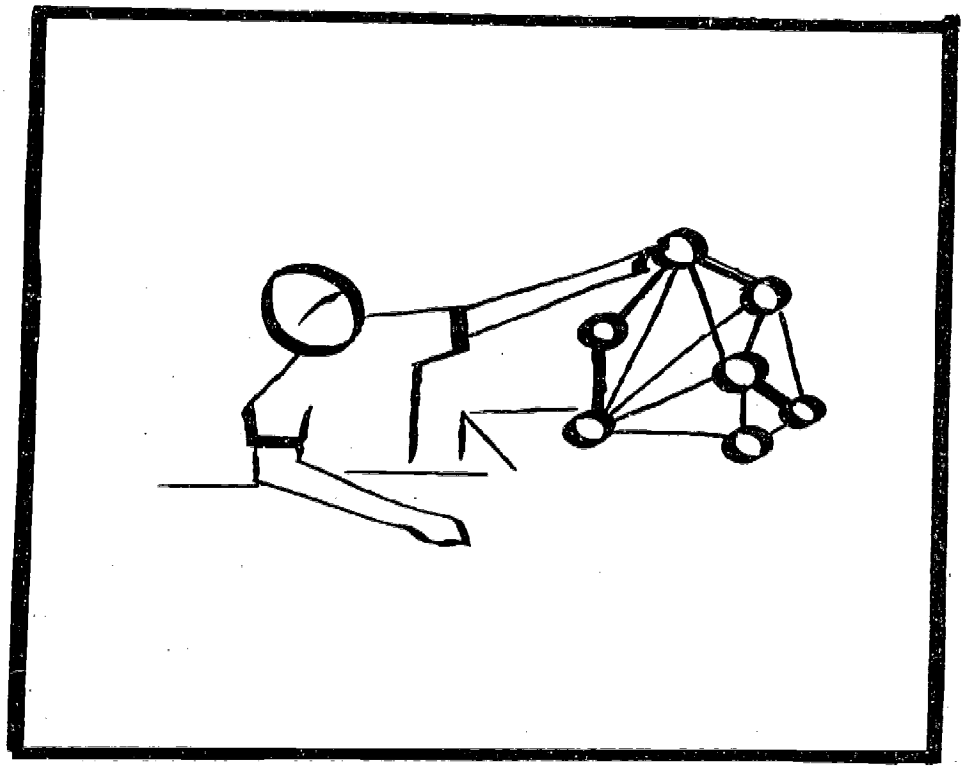
VIII. Develop an understanding of ecology.

Objective: The student should be able to demonstrate his understanding of the relationships of organisms with their environment and the interaction that takes place between communities or ecosystems.

A. The student will be able to, with field work, develop a picture of the interaction of two different communities side by side and the basic interaction within each community.
B. The student will be able to explain the basic ecological principles that govern and control the works of any ecosystem.
C. The student will be able to discuss and use the information of population genetics to explain food production, dynamics of a population and how changes can occur.
D. The student will be able to do an in-depth study of mans' effect on the environment through work in the field, studying chemically the pollutants to air, water and soil.

RESOURCES:

(Note: Please refer to those resources indicated for Grade 10 Biology.)



# INVESTIGATIVE CHEMISTRY

GRADE ELEVEN

CHEMISTRY BY EXPERIMENTATION

I. Develop an understanding of chemistry as an experimental science.

Objective: Each student should have an understanding of the experimental techniques of science and should obtain the skills necessary to perform the laboratory exercise required in the course.

A. What is Chemistry?

1. Each student will be able to perform the necessary skills of observation and description.
2. Each student will be able to record an accurate description and reach a valid conclusion from the data.

B. Measurement

1. Each student will be able to accurately perform the skills used in the various measurements in an experiment.
2. Each student will be able to calculate accurately the data that is collected and realize the limitations of himself and the equipment.

II. Develop an understanding of the building blocks of matter.

Objective: Each student should have an understanding of the structure and energy of the atom and how more complex forms of matter are combined in building compounds.

A. Atomic Energy

1. Each student will be able to relate how a theory is created.
2. Through the use of a hypothesis, each student will be able to indicate the existence of molecules.
3. Each student will be able to define Boyle's Law and use it to explain the relationship between pressure and voluem of gases.
4. Each student will be able to explain how to determine relative molecular weights.
5. Each student will be able to describe the effects of temperature changes on pressure and volume.

B. Elements, Compounds and Reactions

1. Each student will be able to identify and recognize the symbols, formulas and equations through the use of 3-dimensional models.
2. Each student will be able to identify that basic particles form all matter.
3. Each student will be able to match symbols with the various elements.
4. Each student will be able to identify the common molecular formulas.
5. Each student will be able to discuss the use of chemical equations to describe chemical reactions and compute the balancing of these equations.

C. The Structure of the Atom

1. Each student will be able to relate the basic principle of electrical charges to Coulomb's Law.

2. Each student will be able to indicate the basic structure of the atom.
3. Each student will be able to explain some atomic nuclei are unstable and decay releasing energy called radioactivity.

D. Periodic Table

1. Each student will be able to interpret that the arrangement of elements on the table is a regularity.
2. Each student will be able to relate the group of noble gas are chemically distinctive because of their lack of activity.
3. Each student will be able to explain that the other elements tend to reach greater stability by assuming the electron arrangement of the noble gas.
4. Each student will be able to recognize that the properties of the various elements change as you cross the periodic chart.

E. Making a Believer

1. Each student will be able to deduce from the chemical evidence available to him a basis for the atomic theory.
2. Each student will be able to discuss and apply the following laws to support the atomic theory:
   a. Law of Definite Composition.
   b. Law of Simple Multiple Proportion.
   c. Law of Combine Volumes.
3. Each student will be able to conclude through experimentation that the various parts of atoms exist by the physical evidence produced in the various experiments.

F. Electrons and Where to Find Them

1. Each student will be able to explain that the amount of light as an energy form is relative to the frequency of the light.
2. Each student will be able to relate that atoms exist in a certain stationary state and this characterized by a specific amount of energy.
3. Each student will be able to relate that when atoms go to an excited state, electrons move to other positions and that when they return to a stationary state, light (a form of energy) is emitted.
4. Each student will be able to indicate that electron distribution extends to infinity; therefore atoms have no boundary surfaces.
5. Each student will be able to explain that the motion and spatial distribution of electrons is characterized by quantum numbers.
6. Each student will be able to explain that the energy used to remove the outer most electrons from an atom can be described as ionization energy in that it increases as you go across the periodic table.
7. Each student will be able to describe that successive ionization energies for an element are accountable to the number of valence electrons.
8. Each student will be able to apply the information of ionization energies and electron distribution to the organization of the periodic table.

G. Molecules and How They Are Held Together

1. Each student will be able to explain chemical bonding is due to the electron-nucleau attraction.

2. Each student will be able to relate that bonding capacity is related to electron configuration.
3. Each student will be able to express how molecular shape is related to the shape of the orbitals.
4. Each student will be able to indicate that covalent and ionic bonding are suggested in terms of ionization energies.
5. Each student will be able to discuss the existences of multiple bonds.
6. Each student will be able to compare and contrast the various chemical bonding to explain the shapes and sizes of molecules.

H. How About Solid and Liquid Molecules?

1. Each student will be able to explain van der Wall forces in the weak attraction of certain special molecules.
2. Each student will be able to indicate the metals with low ionization energies and empty orbitals.
3. Each student will be able to explain how compounds with varying ionization energies form ionic bonding solids while other solids are formed by covalent bonding.
4. Each student will be able to discuss and describe Hydrogen bonding with various atoms.
5. Each student will be able to describe the special properties of solids, liquids and solutions.

III. Develop an understanding of the dynamics of chemistry.

Objective: Each student should have an understanding and perceive the changes and transformations that occur in atoms and molecules that we call chemical reactions.

A. How to Calculate Changes

1. Each student will be able to perform, solve and balance equations in accordance with the Law of Conservation of Matter.
2. Each student will be able to apply the mole concept as a principle in solution of problems in stoichiometry.
3. Each student will be able to develop a quantitative sense to his understanding of a chemical equation.

B. Power From the Chemical Bonds

1. Each student will be able to explain that chemical reactions involve energy and its storage in the molecules.
2. Each student will be able to discuss the following Laws:
   a. Additivity Law of Reaction Heats.
   b. Law of the Conservation of Energy.
3. Each student will be able to compare the relative magnitudes of energies involved in phase changes, chemical changes, and nuclear changes.

C. How Fast?

1. Each student will be able to explain that reactions proceed by a series of steps that make up the whole reaction.
2. Each student will be able to describe the collision theory which explains changes in rate, by concentration and temperature.
3. Each student will be able to interpret the effects catalysts have on reaction rates.
4. Each student will be able to define and explain energy of activiation.

D. All Things Being Equal

1. Each student will be able to explain the factors that effect the vapor pressure of liquids.
2. Each student will be able to compare the relationship between vapor pressure and boiling point.
3. Each student will be able to summarize Le Chatelier's Principle.
4. Each student will be able to describe the Law of Chemical Equilibrium as a dynamic balance of microscopic changes.
5. Each student will be able to express what an equilibrium constant is in terms of the law.

E. Will It Disappear of Precipitate?

1. Each student will be able to indicate an ions' behavior is independent of its source and may react differently in the presence of other ions.
2. Each student will be able to interpret that by the use of solubility reules, the occurence of chemical reacitons can be predicted.
3. Each student will be able to calculate by using the equilibrium constant the solubility of substances.
4. Each student will be able to define an electrolyte.

F. Sour and Bitter

1. Each student will be able to relate that the strength of electrolytes depends upon the extent of ionization.
2. Each student should be able to define acids as to their major chemical property - a source of $H^+$ ions.
3. Each student will be able to explain that concentration changes as you approach equilibrium and this process is titration.
4. Each student will be able to desdribe the characteristics and properties of acids and bases.

G. Redox

1. Each student will be able to explain that oxidation reduction is due to electron transfer.
2. Each student will be able to use oxidation tables to predict chemical reactions.
3. Each student will be able to perform the balancing of oxidation reduction reactions.
4. Each student will be able to identify oxidation numbers and explain their use and nature.
5. Each student will be able to relate cell potentials and competitions for electrons.
6. Each student will be able to apply the half-cell reaction to a description of an electrochemical cell.

IV. Develop an understanding of how to use the crossword puzzle.

Objective: Each student, through experimentation, should gain further understanding of chemical reactions and the principles governing them.

A. The Reactive Halogens

1. Each student will be able to explain the physical and chemical properties of Halogens is determined by electron configurations.
2. Each student will be able to describe how haolgens are prepared from natural occuring compounds.

3. Each student will be able to describe oxidizing and reducing agents.

B. The Alkaline Earths

1. Each student will be able to apply the principles he has learned in preceding units to a new group of elements.
2. Each student will be able to perform the experimentation necessary to calculate relative solubility.
3. Each student will be able to perform and predict from the laboratory work the qualitative analysis of a group of elements.

V. Develop an understanding of the neighbors.

Objective: Each student should be able to understand the development of the periodic table by study of the horizontal rows and predicting physical and chemical characteristics.

A. Third Row - Eight Boxes

1. Each student will be able to relate that some substances can act as an acid or a base.
2. Each student will be able to relate the properties of the third row elements.
3. Each student will be able to prepare the elements in the third row through experimentation and have an indication of their occurrence in nature.

B. First Transition Elements

1. Each student will be able to apply old chemical principles to a group of new elements.
2. Each student will be able to describe the peoperties of the first series of transition elements.
3. Each student will be able to identify the regularities of these elements with d-orbital valence elections.

C. The Heavier Ones

1. Each student will be able to discuss the unstable nuclei and its effects on the properties of these elements.
2. Each student will be able to indicate the importance of the proton-neutron ratio.
3. Each student will be able to interpret what nuclear binding energy does and how it effects the properties of these elements.
4. Each student will be able to describe the properties of the rare earths and the radioactive ones.

VI. Develop an understanding of carbon and its many compounds.

Objective: Each student should be able to obtain an understanding of the relative importance of carbon chemistry to his everyday living through technology and to life itself.

A. Carbon Compounds

1. Each student will be able to explain the structure of carbon which gives it its unusual behavior in producing compounds.
2. Each student will be able to discuss how hydrocarbons provide the framework of most organic compounds.

3. Each student will be able to explain how functional groups of molecules determine the chemical behavior of these compounds.
4. Each student will be able to relate the make up of giant molecules - the polymers.

B. Chemistry of Life

1. Each student will be able to relate in general terms that living system function because of various cyclic chemical systems.
2. Each student will be able to explain how the chemistry of the living thing is so different but operates on the same principles as all of chemistry.
3. Each student will be able to explain that living things are a collection of many specialized carbon compounds.
4. Each student will be able to express in basic terms the energy exchanges through respiration and photosynthesis in living things.

C. Earth and Space

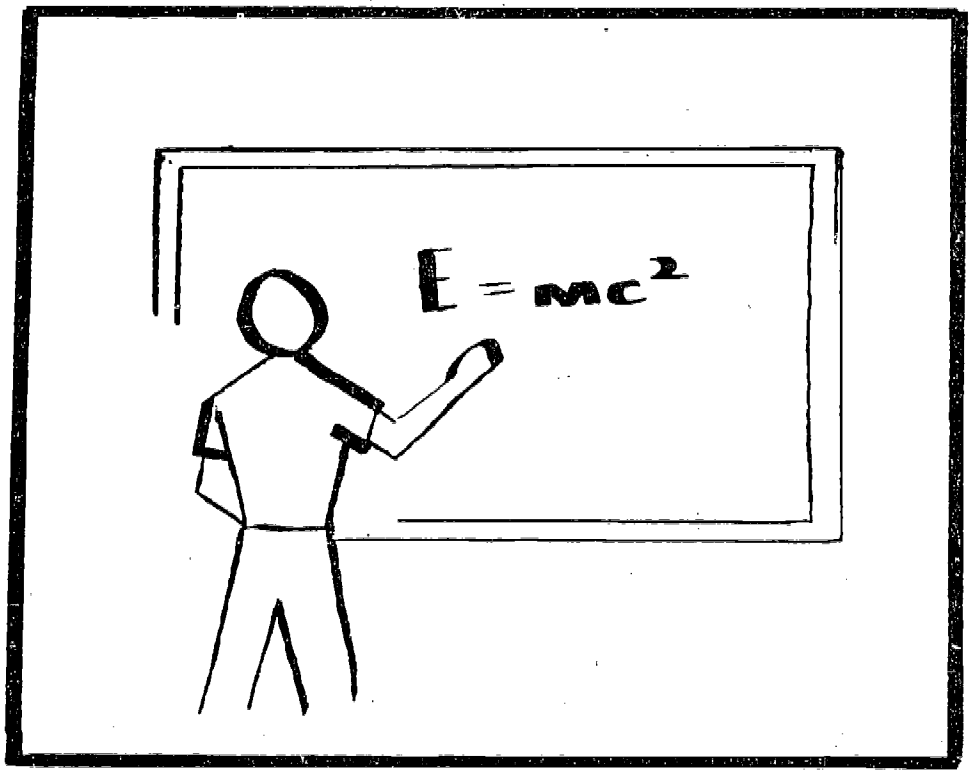
1. Each student will be able to relate how through spectrometry chemical constituents of stars can be identified.
2. Each student will be able to explain that the chemistry of space is a very slow process but similar to what is being done in the laboratory only at a more rapid rate.
3. Each student will be able to discuss how the entire earth is in three spheres (solid, liquid and gas) that correspond to the three states of matter we have been studying throughout the course.

RESOURCES:

Books:

Chemistry - Dictionaries - Miall, Laurence, 540.3 Mia
Chemistry, Medical and Pharmaceutical - Modell, Walter, 615 Mod
Chemistry - Organic - Asimov, Isaac, 547 Asi
Chemistry - Organic - Condon, F. E., 547 Con
Chemistry - Physical & Theoretical - Hoffman, Banesh, 541.3 Hof
Chemistry - Physical & Theoretical - Jughes, D. J., 539.7 Hug
Chemistry - Physical & Theoretical - Life, 541.2 Lif
Chemistry - Technical - Ahrens, Maurice R., 540 Ah
Chemistry - Technical - Jaffe, Bernard, 540 Jef
Chemists - Weeks, Mary E., 540 Wee
Chemical Elements - Weeks, Mary E., 546 Wee
The Chemical History of a Candle - Faradan, Michael, 540 Far
Chemical Industries - Scribner, 660
Chemistry - Ahrens, Maurice R., 540 Ah
Chemistry - Farady, Michael, 540 Far
Chemistry - Jaffe, Bernard, 540 Jaf
Chemistry - Law, Frederick, 920 L
Chemistry - McCormich, Jac, 500 M
Chemistry - Morrison, Robert Thornton, 547 Nor C
Chemistry - Vaczek, Louis, 540 Va
Chemistry - Wetinghouse Research Laboratories, 548
Chemistry - Wetinghouse Research Laboratories, 941.2 Wes
Chemistry - Analytic = King, Edward J., 544 Kin
Chemistry - Biological - Hoffman, Katherine B., 570 Hoff
Chemistry Creates a New World = Jaffe, Bernard, 540 Jaf

Science: A Component of Liberal Education - E. Hutchinson; J. Chemistry Education, Volume 44
Vistas of Science - W. J. Youden; National Science Teachers Assoc., Scholastic Book Services, New York, 1962
Quantitative Analysis - A. R. Olson, C. W. Koch and G. C. Pimentel; Freeman, San Francisco, 1956, Chapter 5
I. Chemistry Education - D. De Bault, 21 526, 1944
J. Chemistry Education, D. De Bault, 21, 575, 1944
The Nature of the Chemical Bond - L. Paulign; Cornell University Press, 1960
Chemical Constitution - Ketelaer, J. A. A.; Elseiver Publishing Co., 1958
Valence - Coulson, C. A.; Oxford Universtiy Press, New York, 1951
Chemical Bonding and the Geometry of Molecules - Ryschkewitsch, T. E.; Reinhold, New York, 1963
Electronic Structure, Properties and the Periodic Law - Sisler, H. H.; Reinhold, New York, 1962
The Hydrogen Bomb - Pimental, G. C. and McClellan, A. L.; Freeman, San Francisco, 1960
Accelerators - Wilson, R. R., and Littauer, R.; Doubleday, Anchor Books, Garden City, 1960
Reaction Rates and Equilibria - Alyea, H. N.; TOPS, J. Chem. Education, 44, No. 4, April, 1967
Why Do Chemical Reactions Occur? - Campbell, J. A.; Prentice Hall, 1965
Elementary Chemical Thermodynamics - Mahan, B. H.; Benjamin, New York, 1963
Elements of Chemical Thermodynamics - Nash, L. K.; Addison-Wesley, Mass., 1962
Acids, Bases and the Chemistry of the Covalent Bond - Vander Werf, C. A.; Reinhold, New York, 1961
Chemistry of Non-Metallic Elements - Sherwin, E. and Weston, G. J.; Pergamon Press, Inc., Lon Island, New York
Distribution of Elements in Our Planet - Ahrins, L. H.; McGraw Hill, New York
The Universe at Large - Bondi, H.; The Science Study Series (PSSC), Wesleyan University Press, Inc., Education Center, Columbus, Ohio
How Old is the Earth? - Hurley, P. M.; The Science Study Series(PSSC), Wesleyan University Press Inc., Education Center, Columbus, Ohio




# EXPERIMENTAL PHYSICS

GRADES ELEVEN OR TWELVE

PSSC PHYSICS

Objective: Each student will be given the opportunity to study the basic physical principles governing energy and matter. Through this understanding man hopefully will be better able to control the physical world. Some traditional introductory topics are omitted because they are being taught in the new junior high programs.

I. Develop an understanding of optics and waves.

A. Examine how light behaves.

1. The student will investigate sources of light.
2. The student will derive the principles of reflection through observation and experimentation:
   a. The student will observe regular and diffused reflection.
   b. The student will observe the straight-line propagation of light and use this principle for drawing ray diagrams.
   c. The student will summarize experimental observations into the laws of reflection.
   d. The student will observe image formation by plane mirror.
   e. The student will observe image formation by curved mirrors and find image by ray tracing.
   f. The student will compare and contrast between real and virtual images.
   g. The student will explain how astonomical telescope applies principles of reflection.
3. The student will derive the principles of refraction through observation and experimentation:
   a. The student will rediscover Snell's Law of Refraction.
   b. The student will measure the index of refraction for some common substances.
   c. The student will explain total internal reflection and compute the critical angle.
   d. The student will observe and explain refraction and dispersion of light by a prism.
   e. The student will observe, explain and draw ray diagrams for refractions by a sperical surface-lens.
   f. The student will determine focal point and measure focal length of a thin lens.
   g. The student will use lensmaker's formula to compute the focal length of a simple lens.
   h. The student will explain how a simple magnifier works.
3. The student will discuss various methods used in determining the speed of light.

B. Develop and evaluate a very simple particle model of light, to analyze the concept of a scientific model.

1. The student will develop the technique of scientific model building and testing.
2. The student will make inferences from the model and explore them (i.e., Existence of light pressure and the association of heat with absorbtion).
3. The student will conclude that the particle model does not account for "partial" refraction and "partial" reflection on surface of refractive material nor the property of defraction, nor the variance

of the speed of light in different refractive materials.

C. Explore the characteristics of waves and their applicability in a model for light.

1. The student will describe and measure wave motion:
   a. The student will explain and trace pulsed waves.
   b. The student will discuss properties of periodic waves:
      (1) the student will measure and compute wave length.
      (2) the student will measure and compute frequency and period.
   c. The student will discover the way waves are reflected and transmitted between two different mediums.
   d. The student will draw by using super position the displacement of two crossing pulses at any given time.
2. The student will recognize by using ripple tank the phenomena associated with wave propogation in a plane, and realize the close similarity between behavior of water waves to that of light:
   a. The student will observe reflection.
   b. The student will observe refraction.
   c. The student will observe dispersion.
   d. The student will observe diffraction.
   e. The student will establish that speed of propogation, the wave length, and the period are related by the equation velocity = wave length x frequency ($V = \lambda f$).
   f. The student will varify Snell's Law relative to wave motion.
3. The student will observe and explain interference:
   a. The student will observe and explain interference of waves generated by two point sources in a ripple tank:
      (1) the student will observe shape of nodal lines.
      (2) the student will relate wave length, source separation, and angles.
      (3) the student will observe and measure phase delay.
   b. The student will observe and explain interference of light:
      (1) the student will perform Young's double slit experiment.
      (2) the student will observe interference of thin films.
      (3) the student will determine wave length from interference effects.
      (4) the student will relate wave length with color.
4. The student will observe and explain diffraction of light:
   a. The student will observe and explain diffraction of light by a single slit.
   b. The student will explain resolution.

II. Develop an understanding of mechanics.

A. Describe various aspects of Kinematics Motion.

1. The student will use proper measuring techniques and accuracy.
   a. The student will express measurements through significant figures.
   b. The student will perform computations with significant measurements.
   c. The student will compute percentage of error.
   d. The student will differentiate between scalar and vector quantities.
2. The student will describe and perform measurements of motion along a straightline path:
   a. The student will establish position and measure displacements.

b. The student will define and measure velocity.
c. The student will recognize that the area under a graph of velocity vs time is equal to displacement for both constant and varying relocities.
d. The student will construct graphs of position vs time and relate instantaneous velocity to the slope of such a graph.
e. The student will define and measure acceleration.
f. The student will recognize that the slope of a velocity time graph is instantaneous acceleration.

3. The student will describe and perform measurements of motion in space:
   a. The student will apply vectors in representing and describing spacial motion and develop computational skills in vectors.
   b. The student will recognize that acceleration results whenever velocity changes either in magnitude or in direction or both.
   c. The student will discuss the limitations of Newtonian Kinematics relative to high speeds.
   d. The student will discuss Kinematic descriptions dependence upon the choice of the frame of reference.

B. Explore dynamics.

1. The student will derive and apply Newton's Laws of Motions:
   a. The student will develop and use Newton's First Law of Motion.
   b. The student will develop and use Newton's Second Law of Motion:
      (1) the student will show through experiments that with a constant mass and a constant force that $\Delta v \propto \Delta t$. Changes in velocity varies direct with change in time.
      (2) the student will show through experiments that with a constant mass and a constant time $\Delta v \propto F$. Change in velocity varies directly with change in force.
      (3) The student will show through experiments the proportionality between inertial and gravitational mass.
      (4) The student will establish experimentally that forces add as vectors.
   c. The student will develop and use Newton's Third Law of Motion.
2. The student will apply Newton's laws to motion at the earth's surface:
   a. The student will discuss and measure free falling objects motion:
      (1) the student will differentiate between weight and mass.
      (2) the student will discuss terminal velocity.
   b. The student will discuss and measure projective motion.
   c. The student will discuss and measure circular motion:
      (1) the student will discuss centripetal force and centrifugal force.
      (2) the student will explain relation between angular speed and transentional speed.
   d. The student will explain relation between simple harmonic motion.
3. The student will discuss Universal Gravitation and the Solar System:
   a. The student will discuss the historical development of a model for the solar system.
   b. The student will recognize that in dynamics the frame of reference is chosen from a logical viewpoint and is not arbitrary.
   c. The student will discuss Newton's Law of Universal Gravitation and its limitations.
4. The student will discuss Momentum and Impulse:
   a. The student will derive from Newton's Second Law the concepts of momentum and impulse and be able to apply them.
   b. The student will demonstrate through experimentation the Law of Conservation of Momentum between interacting bodies.

c. The student will apply the Law of Conservation of Momentum to problem solving.

5. The student will discuss Work and Kinetic Energy:
   a. The student will define the scientific concept of work and apply this definition to problem solving.
   b. The student will define Kinetic Energy and apply this definition to problem solving.
   c. The student will apply the Law of Conservation of Kinetic Energy in Elastic Collision to problem solving.
   d. The student will recognize losses in Kinetic Energy due to frictional interaction.
6. The student will discuss Potential Energy:
   a. The student will explain that the disappearence of Kinetic Energy in an elastic collision is merely stored or potential energy.
   b. The student will expand the potential energy concept to that of the Earth's Gravitational Field.
   c. The student will develop the principle of Conservation of Mechanical Energy for systems with extremely small fractional interacitons.
7. The student will discuss Heat and Molecular Motion:
   a. The student will discuss the motion of the molecules of a perfect gas leading to development of the thermal energy concept.
   b. The student will compare and constrast the energy of bulk motion to that of the random molecular Kinetic Energy.
   c. The student will establish the mechanical equivalent of heat energy.
   d. The student will through calorimentry experiments measure heat capacities and specific heats.
   e The student will discuss methods of heat transfer (conduction and radiation).

III. Develop an understanding of electricity.

Objective: The student will explore electricity and magnetism from the standpoint of matter and to develop some fundamental laws of electricity.

A. Discuss some qualitative facts about electricity.

1. The student will observe that there are two kinds of charge.
2. The student will discuss and perform charging by contact and induction.
3. The student will use equipment to detect the kinds of charge.
4. The student will conclude through experimentation that charge in nature is carried by subatomic electrical particles within gases, solutions, and metals.
5. The student will explain thermionic emission and its use in diodes, electron guns and osci-loscopes.

B. Discuss Coulcomb's Law and the elementary electric charge.

1. The student will develop Coulcomb's Law through experimentation.
2. The student will measure the charge of an alectron - Millikan's Oil drop experiment.
3. The student will summarize and verify basic facts about electric forces on charged objects between parallel metallic plates (capacitor).

C. Discuss energy and Motion of charges in electric fields.

1. The student will apply knowledge gained about energies and electric force fields to determine the mass of an electron and a proton.
2. The student will define and measure electric currents.
3. The student will define and measure the EMF of a bettery.
4. The student will define an electric field and measure its intensity.
5. The student will define and measure the electrical potential difference.

D. Discuss Electric Circuits.

1. The student will apply the concepts of electric field and electric potential difference to open and closed circuits.
2. The student will develop and apply Ohm's Law.
3. The student will conclude that in any circuit the sum of the potential differences equals the applied EMF.

E. Discuss Magnetic Field.

1. The student will use compass needle to sense direction and existance of magnetic field.
2. The student will describe the two main sources of magnetic fields (i.e., pemanent magnets and electric currents).
3. The student will show through experimentation that magnetic fields add vectorially.
4. The student will use the right-hand rule to establish the mutual perpendicularity of I, B, and F. (I = current; B = bield, and F = force).
5. The student will describe the parts and operation of a D.C. motor.
6. The student will describe how magnetic fields can be used to measure the masses of charges particles.

F. Discuss Electromagnetic Induction and Waves.

1. The student will observe that current is induced in a wire loop when there is motion perpendicular to the magnetic field.
2. The student will discuss the wide variety of electromagnetic waves.

RESOURCES:

Books:

Physical Science - Scientific American, 1969, 600 Sci
Physical Science Study Committee - Lab Guide for Physics, 530 Phy
Physical Science Study Committee - 530 Ph
Physicists - Biography - Bitter, Francis, 92 Bi
Physics - Barr, George, 629.2 Bar
Physics - Bitter, Francis, 530 Bi
Physics - Dull, Charles E., 530 Dul
Physics - Fuchs, Walter R., 539 Fuc
Physics - Gottleib, Milton, 530.1 Got
Physics - Physical Science Study Committee, 530 Ph
Physics - Righman, Milton A., 530 Ro
Physics - Physical Science Study Committee, 530 Phy
Westinghouse Research Laboratories - 532 Wes
The Physics and Chemistry of Life - Scientific American, 574.1 Sc
Physics as a Profession - Pollack, Philip, 530.69 Pl
Physics for the Modern Mind - Fuchs, Walter R., 539 Fuc
Exploring Physics - Brinkerhoff, Cross & Lazarus; Harcourt, Brace & World, 1959

(114)

Modern Physics - Dull, Metcalf & Williams; Holt, Rinehart & Winston, 1960
Atoms in the Family - Fermi, Laura; University of Chicago Press, 1954
Reading for Physics - Scientific American; Scientific American Inc., 1959
Physics - An Exact Science - White, H. E.; D. Van Nostrand, 1959
Science Study Series - Anchor Pub., 1959, 56 volumes

Films:

Physical Science Study Committee Physics Film, Modern Learning Aids, 3 East 54 Street, New York
Films from the State Film Library, Helena, Montana:
Electrons, 82
Energy, 105
Series and Parallel Circuits, 1365
Principles of Electricity, 1562
Atomic Energy, 1887
Harnessing Liquids, 1949
Spherical Mirrors: II - Lights Series, 3240
Refraction: III - Light Series, 3241
Lenses: IV - Light Series, 3242
Electricity, 3615
Atomic Radiation, 3770
Atom Smashers, 4016
Ohm's Law, 4118
Demonstrations with Light, 4297
The Laws of Gases, 4666
Laws of Conservation of Energy and Matter, 4668
Neutrons and the Heart of Matter, 5011

REVISION

At your grade level:

1. Do the concepts listed correspond to the interests of the students? If not, why? If so, how?

2. Are the concepts suited to the maturity level and abilities of the students? If not, what do you suggest?

3. Are you able to correlate the science curriculum with other curriculum areas: e.g., language arts, social studies, math, etc. If so, how?

4. Are the hahavioral sub-concepts helpful in developing the main concepts? If not, list those that need revision.

5. Is the content in the various areas too great to be covered in the allotted time? If so, what would you delete?

6. List those resources that you found helpful in developing the concepts.

7. List those resources that you feel could be omitted from the resource list and tell why.

8. List the new source you have found that have been helpful in developing the units.

9. If you have found sources under the wrong heading, list them in the category you feel they belong.

10. Check those teaching techniques that you are using and list any others that you find useful:

_____Lecture - exposition on the part of the teacher.

_____Discussion - exposition on the part of the teacher and/or the student.

_____Experimentation - an activity designed to discover, test, or illustrate some concept.

_____Incidental discovery - happening without regularity or design.

_____Inquiry - teacher poses a problem in such a manner that students must find appropriate raw data and reason out a conclusion.

11. List other suggestions for improving the Science curriculum.

# APPENDIX A

## SURVEYING FORT BENTON'S SCIENCE EFFORTS

Those staff members responsible for any portion of the Science program were asked to respond to the attached survey instrument. The instrument is short and is composed of three parts. Each instructor was to indicate (1) the nature of the science offerings at their level of instruction; (2) what the instructor considered the strengths of that offering; and (3) what the instructor considered the weaknesses of that offering.

The feedback obtained from this instrument is summarized as follows:

1. Fort Benton's past areas of emphasis were:

| | |
|---|---|
| K | - Living things, Earth, Sky, and Forms of Energy. |
| 1 | - Energy, Matter, Weather, Planets, Human Growth, Animals, Plants, Ecology. |
| 2 | - Molecules, Sound, Light, Animals, Plants, Nutrition. |
| 3 | - Energy, Matter and Life |
| 4 | - Sound, Light, Matter, Living Things, Change |
| 5 | - Energy, Matter, Life, Change. |
| 6 | - Environment , Energy, Heredity, Interdependence. |
| 7 | - Life Science. |
| 8 | - Physical Science. |
| 9 | - Earth Science |
| 10 | - Biology |
| 11 | - Chemistry |
| 11 or 12 | - Physics |
| 11 or 12 | - Advanced Biology |

2. Strengths:

   a. Program is quite flexible.
   b. There are some real areas of interest for students.
   c. Classroom laboratories are good.
   d. Sequence seems to be working quite well.
   e. A great deal of "doing" and involvement are necessary.
   f. Program lends itself to the inquiry approach which is felt to be of value.
   g. Field trips are valuable.

3. Weaknesses:

   a. Lack of materials.
   b. Need more field work.
   c. Need for A-V materials.
   d. Too much content to cover in too short a time.

# SCHOOL SYSTEM SELF SURVEY

This survey is being distributed to those members of our staff responsible for any portion of our Science program. Each teacher is asked to reply to all the statements.

Teacher's Name _____

Teacher's Grade Level _____

I. What is the Nature of the Science Offering presently at your grade level? (i.e., what themes, concepts, ideas, etc. do you teach with reference to Science during the course of the year?)

a) Major Themes or Topics

b) Units

c) Concepts

d) Others

Comments:

II. What do you consider to be the strengths of this offering?

III. What do you consider to be the weaknesses of this offering?

# APPENDIX B

## CURRICULUM DEVELOPMENT SURVEY

Various college professors, learning laboratory representatives and State Department representatives were asked to respond to the attached instrument. The purpose was to obtain informative data in the English (Language Arts), Math, Science and Vo-Tech Curriculum areas. The instrument was designed to consider two major areas: (1) General information concerning the individual and agency that individual represented and (2) Specific curriculum information.

Thirty-one questionnaries were distributed; fourteen were returned. The following is an attempt to summarize the information:

It appears as if very few schools in the state are known to be developing curriculum guides at this time. Even though it was felt that many schools are beginning to do "something" in the realm of curriculum, the survey respondents did not for the most part indicate recommended places to visit. Of the programs and schools mentioned as doing "something" in curriculum, it appeared that all had a tendency to be striving toward some form of individualization in those curriculum areas they were concentrating on.

# CURRICULUM DEVELOPMENT

This survey instrument is being circulated among college professors, learning laboratory representatives and State Department representatives. The purpose is to obtain informative data in the English (Language Arts), Math, Science and Vo-Tech Curriculum areas. Your reply to this instrument will be greatly appreciated. Results will be sent to you upon request. A return, self-addressed envelope has been enclosed your convenience.

I. GENERAL INFORMATION

1. Name of Institution or Agency you represent_____

2. Describe the lines of communication you have with the local school districts in regard to curriculum development.

3. How many schools do you personally contact during the course of the year concerning curriculum development and improvement?

4. What is basically the area of concentration that you become involved with in your work with local school districts?

II. SPECIFIC CURRICULUM AREAS

1. Are you aware of any school districts that have developed or are in the process of developing curriculum guides or outlines in the areas of Language Arts, Math, Science and Vo-Tech? (If yes, please indicate)

2. Are there any school districts you would recommend a visitation to concerning their curriculum development? (If yes, please indicate where)

3. Are you aware of any worthwhile and interesting "new" happenings in the area of Language Arts - K-12? (If so, please relate)

4. Are you aware of any worthwhile and interesting "new" happenings in the area of Math - K-12? (Please relate)

5. Are you aware of any worthwhile "new" and interesting happenings in the area of Science - K-12? (Please relate)

6. Are you aware of any worthwhile "new" and interesting ha-penings in the area of Vo-Tech (Home Ec., Industrial Arts, Trades and Industry, Commercial, Vocational-Agriculture). (please relate)

7. Do you have any lists of reference materials that you would share with us concerning any of these curriculum areas? (If so, please enclose list and return with questionnaire)

# APPENDIX C

## SURVEYING CURRENT PRACTICES IN SCIENCE

Various teachers and administrators were asked to respond to the attached questionnaire. The purpose was to obtain informative data concerning current practices in the Science Cu-riculum in the State of Montana. The questionnaire was designed to consider three major areas: (1) General information concerning the school district; (2) Organization of the program; and (3) Nature of the offerings.

Twelve questionnaires were distributed; six were returned. The following information was obtained:

Most schools indicated that their basis for their science programs were their textbooks. All indicated a desire to instill in their students a knowledge of the scientific method of investigation. Many schools are experimenting with a more independent or individualized approach to their science programs. All of the schools replying gave the inpression that they were more satisfied with their science programs than with many other areas of their total school curriculums.

# SCIENCE SURVEY

This survey instrument is being circulated among school administrators and classroom teachers. The purpose is to obtain informative data in the Science Curriculum area in order to assist in the development of a Veritcal Science Curriculum Outline. Your reply to this instrument will be greatly appreciated. Results will be sent to you upon request. A return, self-addressed envelope has been enclosed for your convenience.

I. GENERAL INFORMATION

1. Name of School System_____
2. Superintendent's Name_____
3. Number of Students in System_____
4. Approximately what per cent of the Instructional budget is spent in the area of Science? _____ Dollar Amount? _____
5. Is there a district supervisor in Science? _____ yes _____ no
6. Is there a district curriculum guide provided in Science? _____ yes _____ no
7. How many members are on the total instructional staff? _____
8. Are there any well-established lines of communication between elementary and secondary Science teachers? _____ yes _____ no
9. Is there a Department Head? _____ yes _____ no
10. Comments:

II. ORGANIZATION

1. Is a sequential science program provided? _____ yes _____ no
2. Does the Science Department K-12 have a written statement of its objectives? _____yes _____no
3. To what extent do the time allotments for science courses satisfactorily meet instruction needs?

4. Are individual instruction or special classes available to any student who may have a need?

5. To what extent does the variety of offerings meet the needs of all students?

III. NATURE OF OFFERINGS

1. What knowledges, skills and understandings are developed at each grade or each level of achievement?

K

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2

3

4

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12

2. What offerings should be provided that are not included in the present programs?

3. To what extent does the content of offerings meet the science needs of the students?

4. How much emphaiss is given to the science curriculum in comparison to other major curriculums?

# APPENDIX D

## Reference Materials

The following reference material was researched in an attempt to make this effort as dependable as possible. It was found that no one source pfovided us with the exact formula for our task. However, in searching through this reference material, we were able to develop a curriculum outline we feel fits the needs of the students of Fort Benton.

1. Science Behavioral Objectives, J. C. Flanagan, R. F. Mager and William Shanner, Westinghouse Learning Press, Palo Alto, Calif., 1971.

2. Feasibility Study of Major Efforts to Improve Science Courses in Elementary and Junior High Schools, Washington, D.C., John R. Mayor, Dael Wolfe, AAAS, 1960-61.

3. Science in the Elementary School, Peter C. Gega, New York, John Wiley & Sons, Inc., 1966.

4. Rethinking Science Education, National Society for the Study of Education, 59th Yearbook, Part I, Chicago; University of Chicago Press, 1960.

5. The Changing Curriculum: Science, Richard Haney, Washington, D.C. Association for Supervision and Curriculum Development, NEA, 1966.

6. "Science Curriculum: Unfinished Business for an Unfinished Country", R. T. Tanner, Phi Delta Kapan, Vol. 51, pp. 353-56, March, 1970.

7. Elementary School Science Project (ESSP), University of Illinois, Harper & Row.

8. Elementary Science Study (ESS), Newton Mass., Webster Division, McGraw Hill Book Co.

9. Science Curriculum Improvement Study (SCIS), University of California, Berkley, California.